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E-B
TRACTOR SCHOOL TEXT BOOK

EMERSON BRANTINGHAM
THE E-B LINE
FARM MACHINERY

Published by

EMERSON-BRANTINGHAM
IMPLEMENT COMPANY INC.
ROCKFORD, ILLINOIS U.S.A.

The E-B Tractor School Text Book

Compiled for Use of Students Attending E-B Tractor Schools

E-B Tractor School held in Dec. 1917, for U. S. A. Officers Training Camp, Rockford, Ill.

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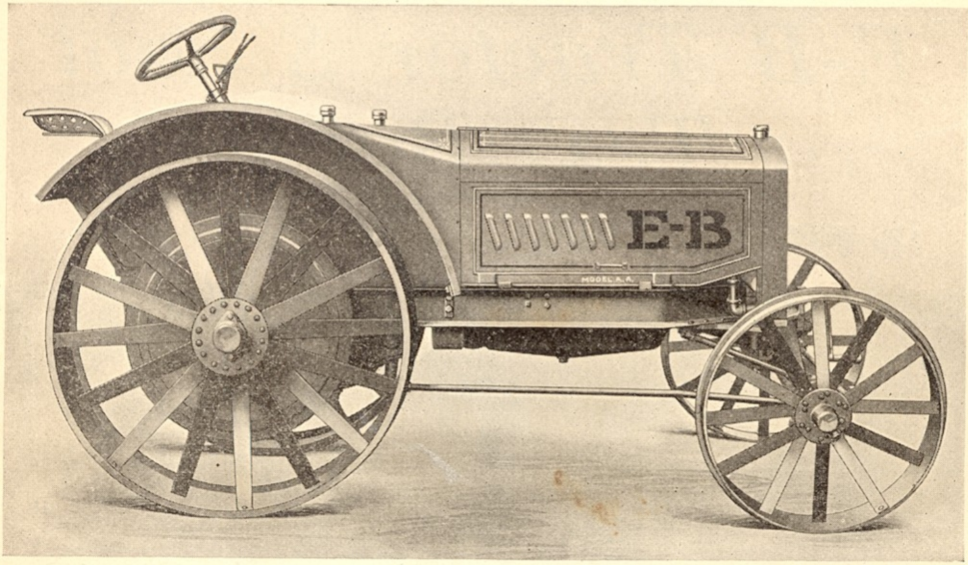
ESTABLISHED 1852 ROCKFORD, ILLINOIS
The Largest Line of Farm Machinery Manufactured



Right Side of E-B 12-20 (S. A. E. Rating) Model AA Kerosene Tractor

MODERN TRACTOR DESIGN

Chart II.

POWER, speed, durability, accessibility, weight and ease of operation are absolutely essential in the make-up of a practical tractor, and should be looked for when purchasing a tractor.

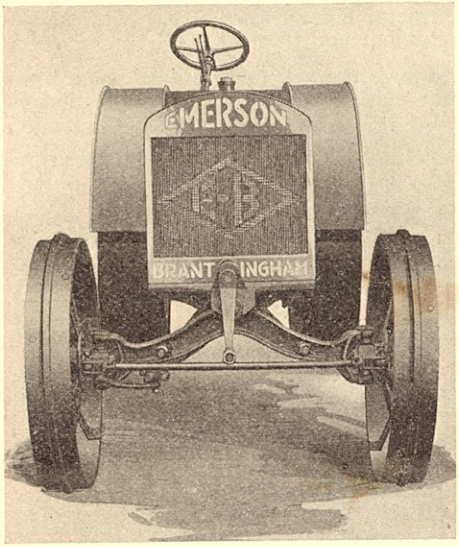
POWER. A tractor is designed as a source of power. The purchaser should see to it that he selects a tractor that has not only sufficient power but a surplus of power to meet his requirements. If this is not done the tractor will constantly be overloaded and this is bound to result in its being a short-lived machine.

(a) The majority of the work done by a tractor is in pulling plows, discs, drills, harrows and similar farm machinery. In doing work of this kind the tractor must also propel itself, therefore it is essential that the tractor be so constructed and of sufficiently light weight as to guard against the using of too great a percentage of the power of the engine in propelling the tractor itself, so that there may be available for actual draw bar work a surplus of power to meet the requirements.

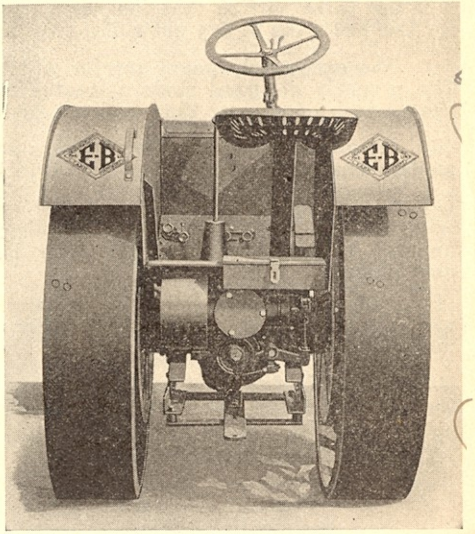
(b) This demands the use of a four cylinder engine, as it has been thoroughly proven that the four cylinder construction gives more power for a given amount of weight than can possibly be obtained from the older style of single and double cylinder engines. In fact, it is largely this one point which has driven the antiquated single and double cylinder tractor from the market to a large extent.

SPEED (a) In this connection the item of speed also comes in as with the lighter construction it is possible to attain a higher speed in miles per hour and allow the implements drawn to be run at the speed to which they are adapted and thereby do a better quality of work.

(b) The only time that a lower speed than that to which the implements are adapted should be countenanced in any way is in getting through hard spots, mud or hills



Front View of E-B 12-20 Model AA



Rear View of E-B 12-20 Model AA

where otherwise a tractor would be too severely loaded if forced to run at the speed at which implements are designed to run. To take care of such places as this, and to guard against the tractor being overloaded, the tractor should be equipped with a lower speed so that when a hard spot or hill is encountered the gears may be shifted into low and the load taken through without undue strain on any part of the tractor.

DURABILITY (a) The question of durability depends to a great extent on the grade of material and workmanship which go into its construction.

(b) The heat treating of steel is becoming a most important art in the manufacture of the modern tractor and when purchasing a tractor we would recommend that you do not lose sight of this item of its construction.

(c) Its equipment in the way of carburetor, magneto, radiator, bearings, etc., should be from manufacturers, the reputation of which for giving satisfactory service is beyond reproach.

ACCESSIBILITY. The construction of the entire tractor must be such as to permit the easy removal of any moving part in the field. If your tractor is constructed in this way, you will make the necessary adjustments as they are required and will not be tempted to run it and thereby impair its general condition when you know that some part of it requires adjustment.

WEIGHT (a) Weight must be as light as consistent with adequate strength. Unlike an automobile, a tractor must not only propel itself, but also must have sufficient power left to do a reasonable amount of work. The amount of this surplus power is dependent on two things—the weight of the tractor and friction drag. Every extra pound of weight over what is actually necessary for strength, saps a little power from the motor and reduces its tractive efficiency. Besides, you are paying good money for fuel to move useless metal. In addition, it makes climbing grades with a load difficult and sometimes impossible.

(b) In the Spring of the year when it is time to plow the ground, in many places it is apt to be soft so that the heavy type of tractor must lose valuable time waiting for the wet spots to dry out sufficiently to prevent miring.

(c) The excessively heavy tractor will tend to pack the soil and produce a hard pan. The properly designed modern tractor will bear much less weight on the ground per square inch of contact than will a horse's hoof.

(d) Now that many women and boys are operating tractors, it is necessary that the modern tractor must be light enough to be easily handled.

(e) Light weight tractors have a much wider range of work as they can be operated at a higher speed thus enabling them to go a greater distance to their work and are so easily handled that when doing belt work the sets can be made quicker and oftener.

(f) Heavy parts are awkward to handle and hard to repair often necessitating the use of a tripod and hoist. The smaller, lighter weight parts in use on some tractors make replacements and repairing easy.

OPERATION (a) It must be simple. A tractor of this kind is naturally adaptable to a greater variety of work than one not so constructed.

(b) The control devices must be easily handled so that women or boys can operate them.

THE TRACTOR
NOT A COMPLICATED MACHINE

Chart III.

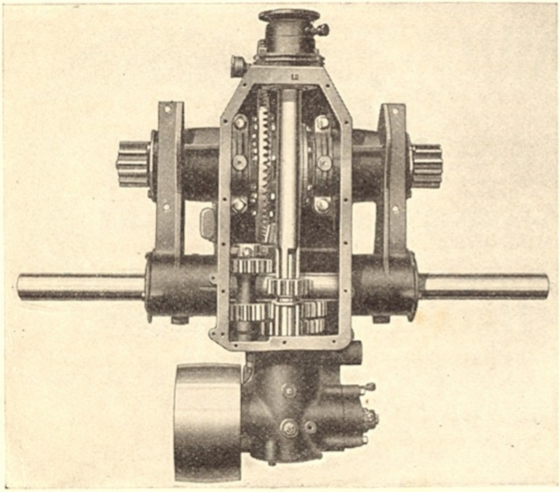
A TRACTOR when viewed as a whole is sometimes unjustly criticized as being a complicated machine. In order that you may form a more clear conception of each individual part of the tractor and the work which it performs, we wish you to think of the tractor in three parts.

MOTOR. First, as the tractor is to be a power giving machine it must have a motor. This is the source of power. The motor will require daily care, which matter will be taken up at some length and in detail later, in the following chapters.

TRANSMISSION. Second, we must have the transmission—the harness that hitches the power plant to the running gear. This harness must be sufficiently oiled to keep it from becomming chaffed or from becoming dry and brittle. This is very simply accomplished by pouring sufficient oil into the transmission housing so that all parts of the transmission are working in a bath of oil. A small plug is provided at the rear of the transmission so that when sufficient oil for this lubrication is in the transmission housing it will just flow through the hole in the rear of the transmission housing when this plug is removed. A heavy steam cylinder oil should be used to lubricate the transmission. All parts, including gears and bearings for shafts, are lubricated by the same bath of oil.

The belt pulley gears and the bearings on which these shafts run are in a small compartment at the rear of the transmission housing, and as this compartment is very small and above the level of the oil in the transmission housing, a separate and different lubricant must be supplied to these parts. A semi-fluid transmission grease should be used in this compartment, keeping the compartment about two-thirds filled at all times.

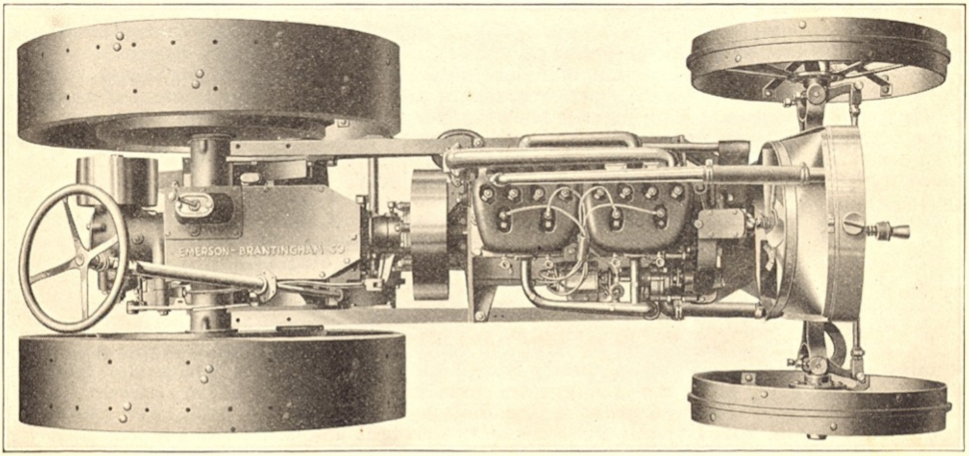
The transmission clutch should be kept properly lubricated at all times except the friction surfaces, and occassionally the friction lagging of the clutch which comes in contact with the fly wheel of the engine should be washed with gasoline. The proper lubrication of the clutch and the occasional washing of the clutch lagging with gasoline will keep the clutch working freely and no trouble will be experienced with this part.



Top view of E-B Transmission Case with cover removed

The power from the engine is transmitted to the drive wheels through gears. These gears may be thrown in or out of mesh. If the gears have been thrown out of mesh, or, in other words, the gear shifting lever has been placed in neutral position, and the clutch has been allowed to engage, thereby rotating the gears on the shaft on which the clutch is mounted, do not attempt to throw the gears in mesh without first fully disengaging the clutch and waiting until the gears have stopped. If you do not do this the transmission will instantly warn you, as, if you endeavor to throw the gears in mesh when they are in motion, the transmission will let forth a growl which means, "Stop this abuse."

Proper lubrication and a reasonable amount of care in handling is the only attention needed on this part of the tractor, and we believe that anybody who has had the care of a team and wagon and who will conscientiously try will not have trouble in giving this part of the tractor the care that it requires.



Top view of E-B 12-20 Model AA Tractor Showing All units in place

TRUCK. Third, we must have a running gear or chassis—a frame and wheels on which to mount the engine. This part will require very little care or adjustment. In fact, we believe that any boy or girl who is capble of greasing and adjusting a wagon will not have any trouble in giving the running gear of the tractor the care which it should receive.

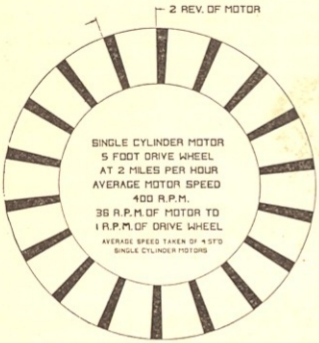


FIG I

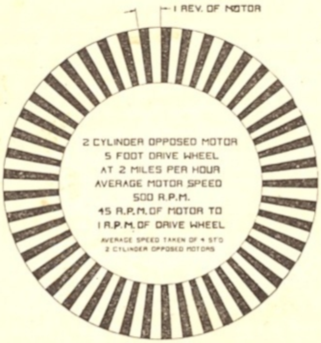


FIG. II

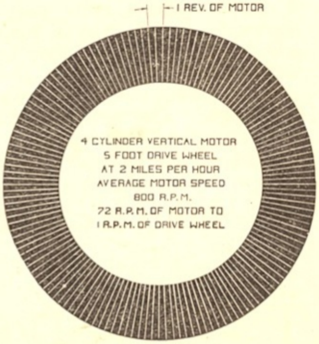


FIG. III

WHY E-B TRACTORS HAVE ALWAYS BEEN EQUIPPED WITH 4 CYLINDER MOTORS

Chart IV.

ONE of the chief reasons for the large number of manufacturers adopting the four cylinder type of tractor motor is clearly shown in the accompanying illustration. Figure 1 of this illustration represents a tractor drive wheel, five feet high, supposedly driven by a single cylinder motor at a speed of 2 miles per hour, the engine speed being about 400 revolutions per minute, or about 36 revolutions of the motor to 1 revolution of the drive wheel. A single cylinder motor actually delivers power a little less than one-fourth of the time. The balance of the time the motor must run on momentum stored up in its heavy fly wheel. The black space in figure No. 1 represents the time that the single cylinder motor is actually delivering power to the drive wheel, while the white space represents the time that the motor is running on its own momentum. This clearly shows a very uneven distribution of power, and a motor so built must necessarily be equipped with a very heavy fly wheel in which to store this energy and the entire transmission, frame, and all parts must be exceedingly heavy to withstand the excessive jar due to these violent explosions.

Figure No. 2 represents the same five-foot drive wheel, supposedly driven at the same speed of 2 miles per hour by a two cylinder motor, running at a speed of about 500 revolutions per minute, or about 45 revolutions of the motor to one revolution of the drive wheel. A two cylinder motor actually delivers power a little less than one-half of the time, and on figure No. 2, as on figure No. 1, one black strip and one white strip represent one revolution of the motor, the black part representing the time that the motor is actually delivering power and the white strip the time when the motor is running on momentum stored in the fly wheel. It will be noted in figure No. 2 that a tractor so designed must run the greater part of the time on energy stored in the fly wheel. This is a considerably better distribution of power than that shown by figure No. 1, and correspondingly lessens the weight necessary in the engine's fly wheel and in the gearing, frame and all other parts of the tractor, but is still not nearly so good a distribution of power as that shown by figure No. 3, which represents the same five-foot drive wheel being driven at 2 miles per hour by a four cylinder vertical motor at an engine speed of about 800 revolutions per minute, or about 72 revolutions of the engine to 1 revolution of the drive wheel. It is seen from figure No. 3 that the four cylinder motor delivers practically a continuous flow of power, each revolution of the engine being represented by two very prominent black spaces and two very faint white spaces.

A motor which runs only a very small portion of the time on stored energy as shown in figure No. 3, need have only a very light weight fly wheel as compared to either of the other two engines, and in delivering power in a steady flow as this motor does, very little shock is caused to the other parts of the tractor and they can on this account be made a great deal lighter without chance of undue wear or breakage. The reciprocating parts of this motor being a great deal lighter cause a corresponding decrease in vibration and thus enable a further lessening of the weight of the tractor frame.

THE A B C OF THE INTERNAL COMBUSTION MOTOR

Chart V.

THE gasoline and kerosene motor has well been termed an "Internal Combustion" motor on account of the fact that instead of burning its fuel in a separate fire box it takes liquid fuel properly mixed with air into the motor cylinders and, after compressing, the mixture is ignited by an electric spark. The rapid burning (explosion) of this mixture creates a very high pressure which forces the piston downward on what is called the "power stroke."

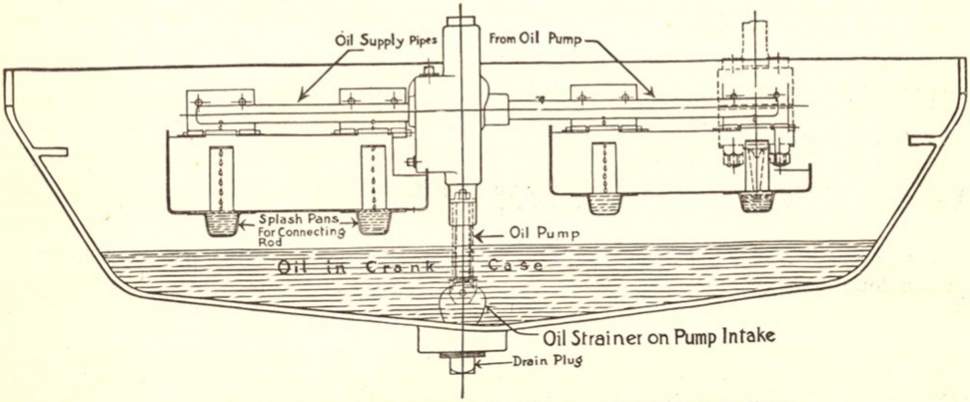
(a) We hear a great deal about the "four cycle" motor. The question may well be asked, "What does four cycle mean as applied to the internal combustion motor?" In the four cycle motor, more properly called the four stroke cycle motor, there are four events which occur in time with the downward and upward strokes of the piston. Taking one cylinder of the ordinary four cylinder engine, let us see what is necessary in order that power may be produced from this cylinder. First, the mixture of fuel and air must be drawn into this cylinder. As the piston is drawn down in this cylinder by the revolving crank shaft a vacuum is built up behind it. By opening the intake valve of this cylinder, air is allowed to enter the cylinder through the carburetor and intake manifold or pipe to relieve the vacuum. As this air is drawn through the carburetor, particles of fuel are lifted by it and mixed with the inrushing air. When the piston has been drawn down to the lowest part of its travel and is ready to return, the cylinder is filled with this mixture. At this time the intake valve should be closed, and as the crank shaft continues to revolve, the piston is forced up to the top of the cylinder, compressing the mixture in the small space or combustion chamber at the top. Thus we have made one complete revolution of the crank shaft but have received no power from the engine. Two strokes of the piston have been completed, and two events have occured, namely, that of drawing the mixture into the engine and second of compressing that mixture. On the third stroke of the piston, the third event occurs—that of igniting the mixture and its rapid combustion. It is this rapid combustion (explosion) which forms a very high pressure on top of the piston and presses it down, thus furnishing the power for turning the crank shaft and doing whatever other work may be connected to it. On the fourth stroke of the piston it is necessary to get rid of the burned gases formed by the combustion which took place on the third stroke of the piston, and to do this the exhaust valve on that cylinder must be opened before the piston starts on its upward stroke. As the piston is forced upward by the revolving crank shaft the burned gases are forced out through the exhaust valve into the exhaust manifold and are carried away.

We have spoken of the opening and closing of the intake and exhaust valves. It will be noted from the foregoing that each one of these valves must be operated at exactly the proper time on every second revolution of the crank shaft. In order that this may be done it is necessary that the cam shaft be positively driven at a speed exactly one-half that of the crank shaft.

(b) The five systems necessary for operation:

1. Lubrication
2. Carburetion
3. Compression
4. Ignition
5. Cooling

We have progressed far enough into the workings of the internal combustion engine so that it may be readily noted that an engine of this kind must have a very perfect lubrication system. This system will demand considerable of your attention. It will also be noted a little later that the mixing of the present day fuel with air is not a small problem and demands that the engine's carburetion system be a perfect acting piece of mechanism, and that it be adjusted and handled with proper consideration. The engine must have the proper compression at all times. It must have a dependable ignition system and an efficient means of cooling. These five systems are of sufficient importance to demand individual attention.



Sectional View of E-B 20 H. P. Tractor Motor Crank Case

LUBRICATION

Chart VI.

THE first oiling system in use on the internal combustion motor was the simple oil hole which required the constant attention of the operator. The first development of the oiling system was the metal oil cup filled with cotton waste, which, when saturated with oil would hold sufficient for something over half an hour. An improvement on this was the glass oil cup which automatically fed out its oil and needed to be filled only a few times a day. The splash system and the force feed system were next used and while they were both a big improvement on the previous methods, they both had their weak points. The most modern and efficient system in use today is the splash and circulating pump system which combines the best points of the splash and force feed systems with none of their disadvantages.

In operating tractor motors equipped with the splash and circulating pump system, there are only two main points to be remembered, A and B on the chart.

(a) **Oil level must be maintained.**
  (1) Gauge on crank case shows oil level.
  (2) Gauge on dash reads from 2 to 5.
  If sufficient oil in case.
  If oil is proper density.
  If oil is circulating properly.
(b) Oil must be drained from crank case regularly to insure clean oil. Oil is cheaper than repairs.
(c) Hard oil cups should be filled daily and screwed down two or three turns twice daily.
(d) Transmission case oil must be replenished as needed.
(e) Use only oils known to be suitable to conditions under which they operate.

To properly lubricate a machine, there must be a thin layer of oil between all moving parts, thus keeping the moving parts from coming directly in contact with the bearing metal. The kind of oil that should be used to form this film varies a great deal, depending on the service demanded of it. The more liquid this oil may be and still maintain this film of oil between moving parts, the less energy must be expended in moving these parts one upon another. For instance, the small ball bearings in the magneto are not called upon to stand any severe pressure or strain, neither are they called upon to stand intense heat which naturally makes oil thinner and more viscous. Therefore, the proper oil for these bearings may be very much lighter bodied oil than the oil which would be suitable for the main bearings of the crank shaft or for the lubrication of the pistons and cylinders where the oil is subject to intense heat and heavy pressure.

This film of oil must entirely cover the bearing surfaces of all moving parts of the motor. In giving this perfect distribution of oil, the splash and circulating pump system of lubrication has been found most valuable for tractor use.

The oil for use in a tractor motor gets its most severe test on the upper end of the piston, and the proper oil to use is an oil which, although as fluid as possible, will maintain a film of oil between every part of the pistons and cylinders at all times and still which when exposed to the very high temperature on top of the pistons will immediately burn clean.

A sufficient amount of oil must always be kept in the motor to insure proper circulation of the oil and the quality of this oil must always be such that a film of oil will always be present between all moving parts.

Oil is not everlasting but will wear out with use. On this account we recommend that the crank case of the motor be entirely cleaned of worn and dirty oil after every thirty hours use and that the crank case be filled with good clean oil which will meet the above requirements.

WHY MOTORS MUST BE SPECIALLY DESIGNED FOR OPERATING ON KEROSENE

Chart VII.

1. Cylinders must be so constructed that the heat from all parts will be carried off by cooling system.
2. Special design of piston with adequate facilities for cooling necessary.
3. Valves must be so constructed and located as to facilitate cooling.
4. No sharp projections are allowable within the combustion chamber.
5. Compression in a properly designed kerosene engine is lower than in gasoline engine.
6. Intake manifold must tend to increase velocity of incoming mixture.
7. Spark plugs must be self-cooling.
8. The cylinders must not be expected to do the work of the carburetor—a real kerosene carburetor must be used.

Kerosene and the heavier fuels are at the present time used almost exclusively for tractor use. In speaking of the carburetion of these fuels the kerosene motor must necessarily be viewed in connection. A kerosene carburetor can be of no use except when attached to a kerosene motor. While the general appearance of the kerosene motor of today may be so nearly like that of the gasoline motor of a few years ago it must be conceded that to satisfactorily operate on kerosene the motor must have some changes which, though they may look trivial, make a great deal of difference in the success which may be had in operating with the heavier fuels. All parts of the cylinders and pistons must be entirely free from sharp points or projections of any kind which might tend toward making the perfect cooling of the motor more difficult, and all parts must be designed with every known device for the adequate cooling of the motor. The motor must be so constructed that when a proper mixture of fuel and air has once been formed by the carburetor there is no chance for it to condense. Granting that the motor is properly made for the use of the heavier fuels, the work of the carburetor consists in supplying the proper amount of fuel and air at all times and the proper mixing of these elements. When burning gasoline this is not a very difficult problem, as when gasoline is drawn rapidly through a small opening it very readily mixes with the air and forms a suitable combustable mixture for use in the motor; but with kerosene this is not the case and it has been found to be absolutely necessary to use heat to first vaporize kerosene before it can be suitably mixed with the air for use in the motor. This is more especially true when the motor is not under load and on account of this condition further difficulties are incurred. The only heat available for vaporizing these heavy fuels is the heat of the exhaust of the motor. It will be noticed that it is necessary to use this heat to the greatest extent when the motor is not under full load. It will also be noticed that this is the time when the heat of the exhaust is at its lowest. Only sufficient heat to keep the mixture in the form of a dry gas is desired, and as the heat of the exhaust be-

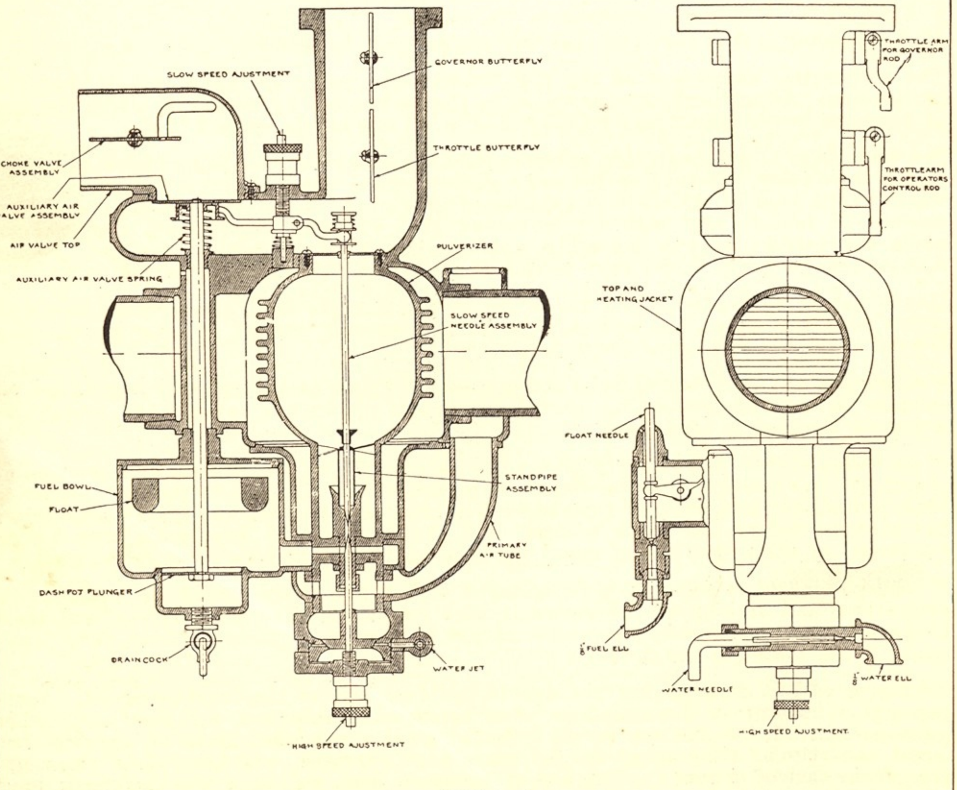


FIG 6

Sectional View of Producer Type Carburetor

comes more intense as the load increases, it may readily be seen that the motor's carburetion system must be capable of automatically reversing the heat conditions which are forced upon it.

The carburetion equipment of the E-B Tractor automatically takes care of these requirements.

CARBURETION

Chart VIII.

1. Must supply proper amount of fuel and air.
2. Must properly mix fuel and air.
3. Mechanical Atomizers—The Multiple Jet Standpipe.
4. Heating fuel gives good power but is not flexible.
5. Heating air gives flexibility but decreases power.
6. To obtain necessary flexibility, mixture must be taken in quite hot at light loads and idling.
7. To obtain necessary power, mixture must be taken in comparatively cool when under load.
8. The producer type Carburetor fills these requirements automatically.
9. Preignition—its cause—methods of prevention.
10. Carburetor leaks—Gaskets—Let the engine talk to you.

The carburetion equipment of the E-B Tractor automatically takes care of these requirements. Adjustments are provided on the carburetor by means of which the flow of kerosene to the motor may be regulated at all engine speeds and loads.

See that these adjustments are so made that regardless of conditions under which the motor is running, whether at the very slowest speed possible for it to run or under the heaviest load of which it is capable of operating, it receives exactly the proper amount of fuel to mix with the inrushing air. If these adjustments are properly made the motor will run smoothly and fire evenly at all times. By having such adjustments properly made, your success in operating with kerosene as fuel is assured.

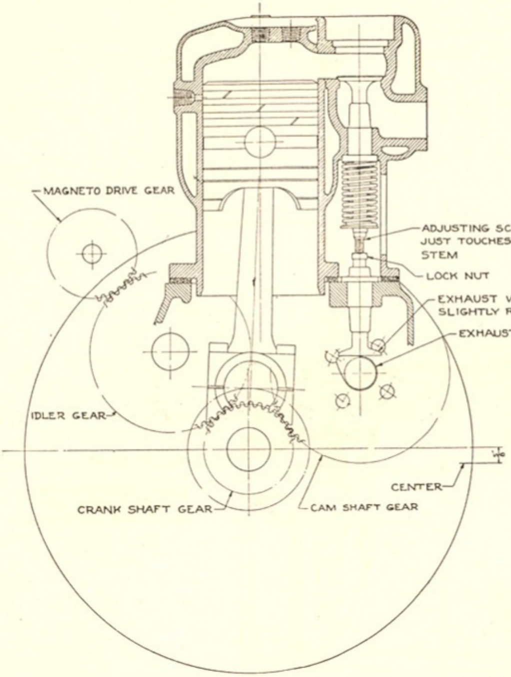
It will not be necessary to use any water in the mixture until pre-ignition occurs, at which time the water needle should be turned on only enough to stop pre-ignition. Do not flood the mixture with water.

Pre-ignition can be detected by a sharp metallic knock in the cylinder caused by the mixture in the cylinders being ignited before the piston has reached the proper position for ignition to take place.

If excessive carbon deposits are allowed to accumulate on the pistons and combustion chambers, pre-ignition will be much more noticeable, as carbon points protruding from the pistons and walls of the combustion chambers will become red hot and ignite the mixture before the spark occurs. The same is true of any spark plug having electrodes or other protruding metal parts which do not radiate their heat readily.

When the tractor is shipped, it is equipped with spark plugs having no heavy metal projections and as long as the motor is kept reasonably free from carbon and these plugs are used, it is rarely necessary, except in very hot weather and on very heavy loads, to use water in the mixture.

Excessive carbon deposits are not due to the fuel, but to the lubricating oil. Sooty deposits will occur in the cylinders when kerosene is used and will also occur when gasoline is used, but the use at all times of good, clean lubricating oil and the frequent and regular flushing of the cylinders with kerosene, will keep them clean and free from carbon deposits. The use of kerosene does not have any injurious effect on the motor, but in order to burn it with the greatest amount of success, the motor must be kept in good condition and the proper kind of lubricating oil must be used.



Sectional View of E-B 20 H. P. Kerosene Motor

COMPRESSION

Chart IX.

Cause for loss of Compression. Escaping compression causes lack of power; waste of fuel; missing; motor heating; and general unsatisfactory motor operation.

Most Common Causes of lack of compression are leaky valves; leaky valve caps; leaky spark plugs; lack of lubrication; or worn piston rings and pistons.

If Valves Leak—grind them into their seats, using valve grinding compound. Oscilate—do not rotate.

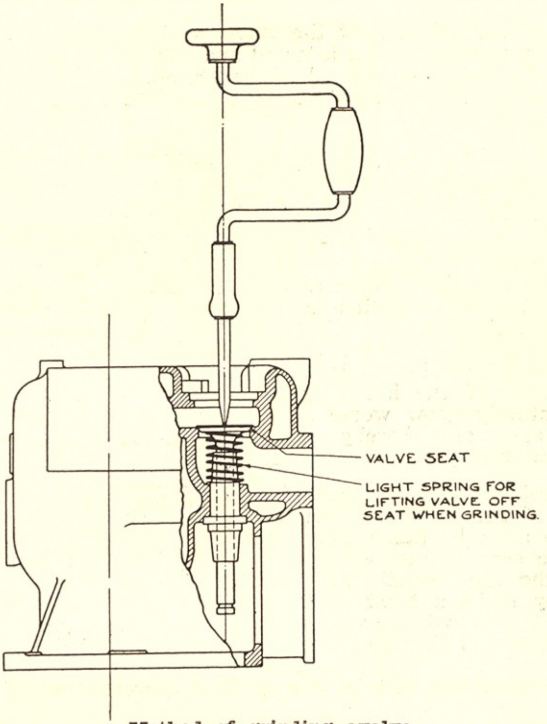
Leaky Valve Caps: Scrape and wash valve caps, gaskets and seats in cylinders. Do not tighten excessively. Moderate pressure will make joint tight if clean.

Leaky Spark Plugs: If plugs are taken apart, clean thoroughly and screw in tight.

Lack of Lubrication: Drain and wash motor if necessary. Fill with good, fresh, clean oil.

Worn Piston Rings and Pistons: Caused by poor lubrication—top ring and groove wear first caused by poor oil not standing higher temperature—renew worn parts.

While it is true that a proper mixture of kerosene and air will not stand as high a compression as will a proper mixture of gasoline and air, it is also true that to have a kerosene motor operate properly it must be closely watched to see that no leaks of compression occur. The primary reason for the necessity of having a lower compression on a kerosene motor is the fact that a properly mixed charge of kerosene and air will ignite more readily than a corresponding mixture of gasoline and



Method of grinding avalve

air. If there is any leak in the combustion chamber through which compression may escape it must be borne in mind that the hot gases will also escape through this opening on the combustion stroke and if leakage of this kind occurs the parts adjacent to this leak will surely become over-heated, and will lend a great deal towards causing pre-ignition which is so detrimental to the development of power and also to the life of the motor.

The most common causes of the loss of compression are leaky valves, leaky valve caps, leaky spark plugs, lack of lubrication or worn pistons and rings.

As long as the valves are kept perfectly clean there is very little danger of any loss of compression or of power at this point. A badly pitted, burned, and leaky valve cannot occur except as the result of some small particle of carbon or other foreign matter having sometime previously been lodged between the valve and its seat in the cylinder. This is the start from which further trouble results. Any foreign matter having lodged this way between the valve and its seat allows a small leak of compression and of the hot gases due to the combustion within the cylinder to escape through the opening. Thus a badly burned and pitted valve is the result of these small tongues of very hot flame shooting past the valve and its seat in the cylinder during each combustion stroke. To guard against this, see that your lubricating oil is always clean and of a proper quality for the lubrication of the motor. See that the mixture supplied the motor by the carburetor is always of the quality that will burn immediately when ignition takes place. In spite of this some carbon and foreign matter will accumulate in the combustion chambers and on the pistons, valves, etc., but the regular flushing of the cylinders with kerosene will soften up these particles and they will be expelled from the motor.

If this care is taken the grinding of the valves will not be required very frequently. However, if any loss of compression is noted and can be traced to a leak in the valve, the valve should immediately be ground. When grinding the valve use a fine grade of emery and oil or a valve grinding paste and oscilliate the valve on its seat in the cylinder—do not rotate.

It may readily be noted in the operation of a tractor that the exhaust valves require grinding a great deal more frequently than do the intake valves. This is accounted for by the fact that when the intake valves are open a clean cool gas is rushing through them. There can be very little impurities in this mixture, and as a result there is very little tendency for anything to interfere with the proper seating of the intake valves when they are allowed to return to their seats in the cylinders. On the other hand, when the exhaust valves are open, all of the impurities due to the combustion within the motor cylinders are forced out past these valves and as a result of this, when the exhaust valves return to their seats it is barely possible that some small particles of foreign matter may be caught between the valves and their seats in the cylinder and cause leaks at that point. These leaks as above outlined, will allow the escape of the hot tongues of flame on the combustion stroke and the leak will eventually grow worse and worse until it is necessary to grind the valves into their seats and thereby restore the motor to its original condition so that the proper power may be developed from it.

A leak will very seldom occur at the valve caps unless the caps have been removed for an inspection of the valves. When it is necessary to remove the valve caps, a great deal of care must be taken when replacing them in the cylinders to see that the valve caps are scraped and washed perfectly clean and that their seats in the cylinders are in the same condition. See that the valve cap gaskets are in such condition that they make a tight joint at this point. They must also be scraped and washed so that there will be no chance of some small particles of carbon being lodged on the gaskets and thereby causing an uneven seat between the valve cap and its seat in the cylinder. If care is exercized to see that these parts are properly cleaned before being re-installed in the engine, a great deal of pressure will not be required on the valve caps in order to insure a tight joint, and, on the other hand, if any particle of dirt is allowed between the valve cap and the gasket or between the gasket and the cylinder, no amount of pressure on the valve cap will stop the leak.

The spark plugs must be screwed into the cylinders sufficiently tight to guard against a leak of compression occurring between the spark plugs and the cylinders. It is equally important that no leak should occur past the porcelain of the spark plug.

It should rarely be necessary to clean the spark plugs, as, if the lubricating oil used is in the proper condition and the carburetor is properly adjusted, the spark plugs will burn clean and the removing of the spark plugs and taking them apart for the purpose of cleaning will not be necessary very often. However, if this should be necessary, when the spark plugs are reassembled, see that no dirt is allowed to remain between the porcelain and the gasket on which it rests or between the gasket and the body of the spark plug. If any dirt is permitted to remain on these parts, a leak will occur which will cause the overheating of the spark plugs, leading to pre-ignition, and the results obtained will be a great deal the same as though a leak occured at the valve cap.

Lack of lubrication, being the lack of a film of oil between the piston and cylinder walls, will result in the loss of compression at this point. Without this film of oil, a tightly sealed joint cannot result between the piston and cylinder. A leak caused in this way will go from bad to worse, as without lubrication the rings will tend to stick on the cylinder wall and require a great deal of force to slide them up and down in the cylinders as the crank shaft revolves, and this excessive pressure and pounding on the pistion rings and the grooves in the pistons, will result in a loose fit between the piston rings and the piston. The leak thus caused will grow worse as long as this condition is allowed to exist.

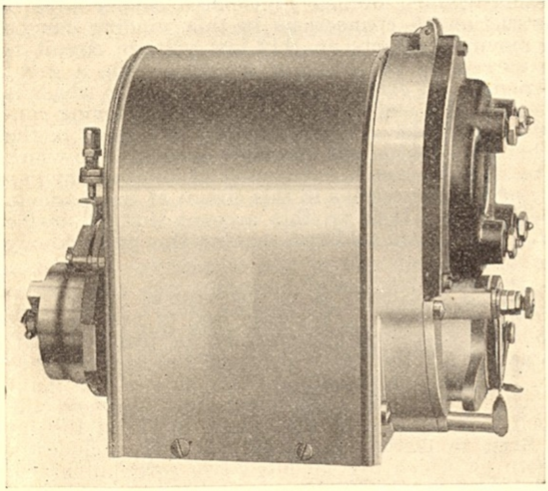
Lack of lubrication is not always caused by the oil being low in the crank case but may also be caused by the oil in the crank case having lost its body and lubricating qualities. When oil has deteriorated to this condition it loses its ability to withstand heat. The results of using oil of this kind are a great deal more noticeable on the top ring on the piston and on the groove in which it works than on any of the other rings. An example of this may be noticed by examining the scrap pistons to be found in any garage or repair shop. Invariably the top ring groove on these pistons will be very badly worn while it is quite probable that the bottom ring groove will be in a great deal the same condition that it was when the piston was new, showing that oil was used in the lubrication of that piston which was not able to withstand the heat present at the top of the piston and, therefore, allowed the top piston ring to run dry and cause undue wear and pounding to result between the top piston ring and the groove in which it works.

To overcome a lack of compression caused by a lack of lubrication, drain all of the oil out of the crank case and thoroughly clean the case. Then fill the motor base with good fresh, clean oil. If the pistons and piston rings have become worn as above outlined the only way of restoring compression is to replace the worn parts with new ones.

IGNITION

Chart X.

Induction Type Magneto, vs Shuttle Type Magneto.
Magnetism is a peculiar form of electricity.
Disturbance of magnetic flow sets up electric current in low tension winding.
Breaking of low tension circuit sets up a very high voltage in high tension winding.
The condenser—The Safety Gap—The Impulse Starter.
Keep the circuit breaker housing and distributor clean.
Circuit breaker points should separate 1/64".
Use platinum file only enough to keep points flat.
Use very little oil. Three or four drops of oil once each month is sufficient.
Do not dismantle.



K. W. High Tension Impulse Starting Magneto

The ignition or setting on fire of the mixture in a tractor motor is by means of an electric spark. In the study of ignition we naturally ask, "What is electricity?" This question cannot be answered, as so far nobody has been able to find out what electricity is. Means, however, have been discovered whereby electricity may be generated and ways have also been designed to harness this form of power.

Magnetism is a peculiar form of electricity. It has been found that some metals when held in the path of an electric current become magnetized and it has also been found that these metals possess varied ability to retain this magnetism. This discovery has led to the development of the magneto in which the current used for ignition purposes is derived from permanent magnets, made of a special grade of steel which possesses the ability to retain electricity in the form of magnetism indefinitely after being magnetized by an electric current.

The flow of electricity on an electric wire may be compared to the flow of water through an ordinary water pipe. The pressure on a water pipe is recorded in pounds pressure to the square inch. This may be likened to the voltage of an electric current. The flow of water through a pipe is measured in gallons or in cubic feet. This compares favorably with the number of ampers of an electric current.

The pressure or voltage of the current derived from the permanent magnets of a magneto is very slight and in order that this current may be used for ignition purposes, it must be made capable of jumping an open gap through the air. Air is an insulator of electricity. It must also be remembered that the ability of air as an insulator of electricity increases as pressure is applied to it. The demands made on an ignition system are that the equipment used be capable of generating an electric current that will jump across the points of the spark plug when set at a distance of 1/64th of an inch from each other at a pressure of from 60 to 80 pounds to the square inch, and in order that the ignition system may be reliable it must be as simple of construction as possible. As the pressure used in the motor cylinder is approximately five times that of the atmospheric pressure, it is apparent that if anything like adequate ignition be secured, the current used must be capable of jumping a gap in the open air at atmospheric pressure of at least 5/64 of an inch, and to this must be added a sufficient margin of safety to insure its performance in this manner. Careful experimental work has shown magneto manufacturers that to give reliable ignition service the electric current used must be of a voltage in excess of 20,000 volts.

It is seen at once that the current derived from the permanent magnet is entirely incapable of giving this service. It has been discovered, however, that by disturbing the flow of this magnetic current an electric current of a higher voltage will be set up in the disturbing element. Working on this discovery, several magneto manufucturers have built magnetos in which the element which disturbs the magnetic flow, is made in the form of several turns of rather coarse insulated wire mounted on a shaft which revolves between the ends or pole pieces of the magnets. This is called the shuttle type of magneto, and although a great many magnetos of today are of this type, the necessity of collecting the current thus generated by means of a brush, or wiping contact, constitutes a serious drawback.

In the design of the K. W. Magneto this winding of heavy insulated copper wire is stationary, and by means of this construction all connections to this winding can be made rigid and thus all trouble with moving contacts on this low voltage circuit is made impossible. The voltage of the current in the primary winding while a great stationary, and by means of this construction all connections to this winding which is known as the primary winding, can be made rigid and thus all trouble with moving contacts on this low voltage circuit is made impossible. The voltage of the current in the primary winding while a great deal higher than that of the magnetic current from which it is derived is still very low—from 20 to 30 volts—and is not capable of jumping any gap whatever in the open air. The necessity of the connections in this circuit of the magneto being firm and sure is, therefore, readily seen. It is on this account that all inside primary circuit connections in the K. W. Magneto are soldered, making this point doubly sure.

Brass, while a conductor of all other forms of electricity is an insulator of magnetism. The base of the magneto on this account is of brass. The lower end of the magnets attach at either side of the magneto to a cast iron plate which in turn attaches directly to the brass base of the magneto. All the north poles of the magnets are placed on one side of the magneto and all south poles on the other side of the magneto. These cast iron plates, therefore, act as magnetic conductors between the ends of all the magnets on the magneto. On this magneto, which is called the inductor type of magneto, the method used to disturb the magnetic flow includes a shaft running lengthwise of the magneto on which are mounted two soft, laminated, iron blocks. This shaft passes directly through the center of the primary winding and is mounted on ball bearings at either end in such a way that it does not touch the winding at any point. At either side of this winding is a laminated iron block of such length as to barely be able to rotate between the pole pieces of the magnets without touching them. These blocks are mounted on the shaft at right angles to each other. Electricity can always be depended upon to follow the course of least resistance and as the rotor shaft is considerably above the pole pieces of the magneto, it is impossible to form a direct connection from one pole piece to the other through one rotor block, but instead the magnetic current must go up one-half of one rotor block and pass to the other rotor block through the rotor shaft and then down the other half of the opposite rotor block to the pole piece on the opposite side of the magneto. In doing this it will be noticed that the magnetic current has been induced to travel through the center of the primary winding. This current is then abruptly cut off by the further turning of the rotor shaft, and at the next quarter turn of the magneto the block at the opposite end of the rotor shaft comes in contact with the north pole of the magneto and the current travels up this half of the rotor block to the shaft and through the shaft to the rotor block at the opposite end of the magneto and then down this rotor block to the south pole of the magnet. It will be seen that in doing this the magnetic current has not only been disturbed but is actually travelling in the opposite direction from the course taken formerly by the magnetic current, and it is this constant disturbing of the magnetic current at every quarter turn of the rotor shaft that sets up the electric current in the primary winding of the magneto. No one knows why. We only know that these results can be obtained by treating the current flow thus.

As we have seen, the current thus obtained, while considerably higher in voltage than that with which we originally dealt is still not nearly high enough in voltage to jump across the points of the spark plugs, so we must get the voltage of this current up still higher. Directly on top of the primary winding but insulated entirely from it and having no connection with it, is what is known as the high tension winding. This winding consists of a great many turns of very fine insulated wire. By quickly opening the primary circuit at the time when the voltage is the highest in that circuit, a very high voltage current is set up in this high tension winding. One end of the primary circuit is attached to the base of the magneto, or as it is commonly called, "grounded." Mounted on the rotor shaft at the front end of the magneto is what is known as the circuit breaker housing. In this housing are two platinum points. One of these points is also grounded. The other is insulated from the circuit breaker housing, but is connected directly to the opposite end of the primary winding from that which attached to the base of the magneto. The platinum point which is grounded is carried on a small rocker arm and is mounted in such a way that a spring tends to hold it in contact with the insulated platinum point. A cam on the front end of the rotor shaft operates this rocker arm and on a four cylinder magneto allows the platinum points to come in contact twice in each revolution of the rotor shaft, and as often breaks the circuit. One end of this high tension circuit is also grounded to the base of the magneto. The other end connects with what is known as the distributor, the function of which is to distribute this current to the four cylinders in their proper order. The magneto on a four cylinder engine is driven at exactly engine speed. The distributor of a magneto is run by a gear from the rotor shaft of the magneto at exactly one-half engine speed. The high tension current, a current which ranges from 20,000 to 30,000 volts and perfectly capable of jumping a gap in the open air of more than one-quarter of an inch, is carried into the center of this distributor and distributed to the four terminals located in a circle around the distributor moulding by a brass segment which is mounted on this gear and rotates with it, thus carrying the current to the spark plugs in each of the four cylinders in their turn. When attaching the magneto to the engine it must be timed so as to cause the breaking of the primary circuit and thereby setting up current in the high tension circuit at exactly the right time to secure the most power from the mixture in the cylinder ignited by it. This point in the E-B motor has been determined and the setting of the magneto is arranged to have the spark occur at that point at full advance. Therefore, when setting the magneto, always set it at the full advance position, that will insure the spark occuring at the proper time when the tractor is pulling a load. Five and one-quarter inches before the center mark for cylinders Nos. 1 and 4 on the fly wheel is a center punch mark

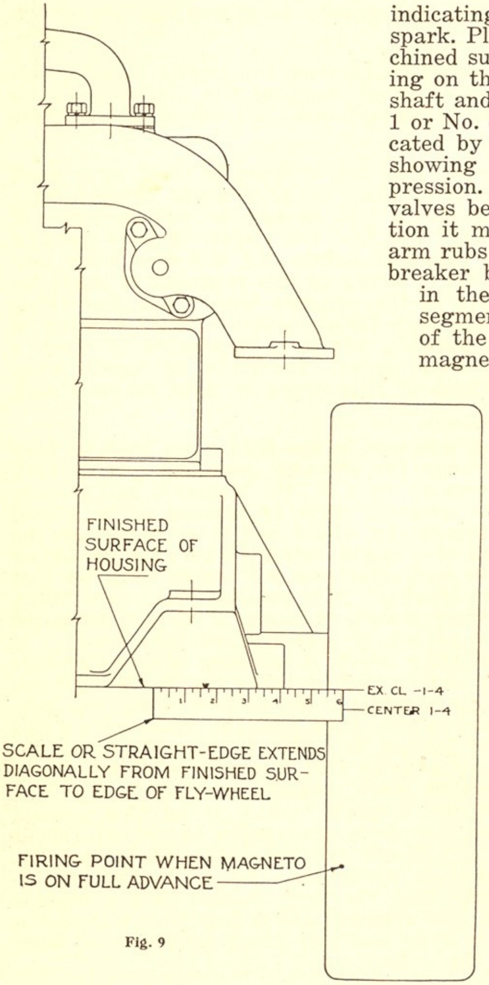

FINISHED SURFACE OF HOUSING
1
2
3
4
5
6
EX. CL. -1-4
CENTER 1-4
SCALE OR STRAIGHT-EDGE EXTENDS DIAGONALLY FROM FINISHED SURFACE TO EDGE OF FLY-WHEEL
FIRING POINT WHEN MAGNETO IS ON FULL ADVANCE

Fig. 9

VIEW SHOWING METHOD OF FINDING CORRECT POSITION OF FLY-WHEEL FOR TIMING VALVES AND MAGNETO.

indicating the firing point at extreme advance of spark. Place this mark in a direct line with the machined surface on the under side of the engine housing on the valve side of the motor. With the crank shaft and pistons in this position either cylinder No. 1 or No. 4 will be in position to fire, this being indicated by both valves for that cylinder being closed, showing that that piston is coming up on compression. If cylinder No. 4 is in position to fire, both valves being closed, turn the magneto in the direction it must run until the brush on the distributor arm rubs on No. 3 brass segment and until with the breaker box in position of full advance the points in the breaker box are just separated. Brass segment No. 3 leads to cylinder No. 4 on account of the firing order being 1, 2, 4, 3. Holding the magneto shaft in the above position, push the magneto forward on the magneto stand, engaging the half of the coupling which is pinned to the magneto shaft with its mate on the drive shaft and bolt it firmly to the stand. See that the coupling lines up straight and does not bind.

When the magneto is set as above, the platinum points in the breaker box of the magneto should be just separated when the magneto is on full advance. The slightest turn of the fly wheel backward should close the gap between the points an the slightest turn forward should cause them to open still more.

The proper opening for the points in the magneto is one sixty-fourth inch at their greatest gap. These points will gradually wear off and require adjusting. If the points open too far it appears that the magneto is not timed just right, therefore, the gap between the points should be correct when checking up the timing as described above.

The breaking of any electrical circuit tends to cause a spark at the point where the circuit is broken. This is especially true when the circuit is broken slowly. An example of this kind may easily be had by opening an ordinary knife switch slowly. A stream of fire so hot as to greatly damage the switch will be the result. The circuit is broken in the circiut breaker housing when the points are properly adjusted to one sixty-fourth of an inch very rapidly, but to still further guard against any spark occuring at the platinum points and thereby greatly injuring them by causing them to burn up rapidly, a small part called the condenser is used. The condenser is made up of alternate layers of tinfoil, and mica or some other form of insulator, and one end of this condenser is connected to the lead running from the primary winding to the insulated platinum point in the circuit breaker housing. The other end of the condenser is grounded to the magneto base. The condesner, properly made and installed in this way. has the faculty of drawing the current away from the platinum points when the circuit is broken, this increases the voltage of the current set up in the high tension winding thus breaking the circuit more abruptly which prevents sparking, and greatly lengthens the life of the platinum points.

The care which a magneto must receive consists in keeping the circuit breaker and distributor housings clean and free from dust or oil, keeping the platinum points flat and smooth and adjusted so that they may break only one sixty-fourth inch at their greatest gap, and in proper oiling.

Do not use ordinary engine oil on a magneto. Use only "Three in One" or a good grade of light sewing machine oil and put only three or four drops in each hole once each month. Too much oil in a magneto is just as bad as not enough. If too much oil is put on a magneto it will work out into the circuit breaker housing and cause a great deal of trouble with the platinum points and will also work into the winding of the magneto and ruin it. The winding of the magneto is made up of a few hundred feet of rather coarse wire in the primary circuit and something like a mile of very fine insulated wire in the high tension circuit. This winding is made up as nearly oil and water proof as possible, but it is impossible to cover a winding in such a way as to be both oil and water proof. Therefore, be careful when oiling a magneto and do not over oil it. Three or four drops of light oil once each month is sufficient.

Do not under any circumstances dismantle a magneto in the field more than to take off the circuit breaker and distributor housings for cleaning purposes. It is very seldom that anything more than this is necessary on a K. W. Magneto, and if anything should go wrong on the inside of the magneto there is nothing to be gained by dismantling it in the field, as the only things you would find in so doing are the parts described above. We have never known of a single instance where the condenser of this magneto has given trouble. We are sure that you will agree with us that the rotor shaft and blocks are immune from trouble. It is possible from over oiling to destroy a winding. This winding, as before stated, is made of almost unlimited length of very fine insulated wire. In the course of manufacture this winding is alternately dipped in an insulating material after which it is baked for twenty-four hours. This process is repeated to such an extent that it takes the K. W. Ignition Company twenty-four days to make a single winding. We believe when you consider the amount of very fine insulated wire which goes into the make-up of this winding and the way in which it must be treated in order to guard against the breaking of the insulation that you will agree with us that it would be a very hopeless task, indeed, to endeavor to repair a broken down magneto winding in the field. These are the only parts on the inside of the magneto and it is on this account that we say never under any circumstances dismantle a magneto except so far as necessary to clean up the circuit breaker and distributor housings and to properly adjust the platinum points when adjustment is necessary. As a further caution against action of this kind we wish to state that the very instant that a magnet is removed from the cast iron plates to which it is attached and is free from a magnetic inductor, thirty percent of its magnetism is gone and can never be reclaimed until the magnet is recharged and thereby fitted for duty.

Do not allow the motor to run any length of time with one of the wires detached from the sparkplug. In so doing, the end of the high tension cable may fall in such a position that the spark will be unable to jump from the terminal on the cable to the motor and when this is the case, the current is forced to travel a distance of about five sixteenths of an inch on the inside of the magneto, from the distributor arm to the brass gear which drives it, and in so doing a strain is imposed on the high tension winding which, if this practice were to be continued might puncture the high tension winding.

The impulse starter on the magneto is designed to furnish a very hot spark for starting purposes. This is accomplished by a lock on the magneto which when tripped allows the rotor shaft of the magneto to be held stationary while the motor is turned a few degrees. The lock is then released and the rotor shaft instantly springs up to its normal position, thereby setting up a high voltage in the primary winding and very quickly breaking the circuit. An adjustment is made on a small adjusting screw on the impulse starter so that when the motor starts and has reached a speed of about 125 revolutions per minute, the impulse starter automatically hooks up and is turned in common with the rest of the rotor shaft.

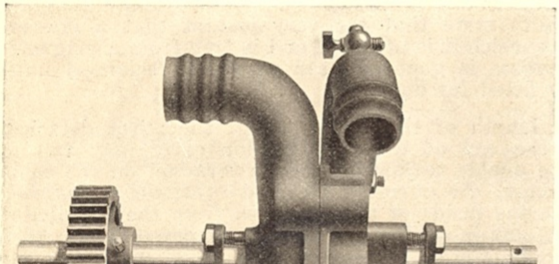
COOLING

Chart XI.

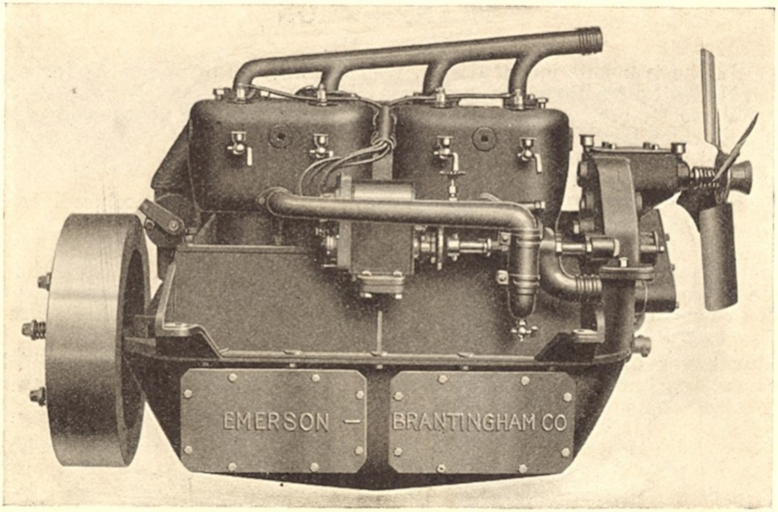
Old method of large water tanks produces unsatisfactory tractor operation.
Large water space around cylinders and valves necessary.
Forced circulation is essential to proper motor cooling.
Fan must be positively driven: The gear drive fan.
Modine Spirex Radiator is most efficient per gallon.
Modine Spirex Radiator is most trouble free

There are tractors on the market which require a great deal of water to be carried on the tractor for cooling purposes. There are other tractors on the market which do not carry so great a quantity of water for cooling purposes, but whose radiators require very frequent filling. Both of these types have serious drawbacks. It is possible by the use of modern appliances to properly cool a tractor motor without carrying a great quantity of water and without its being necessary to fill the radiator often. These appliances, it is true, are expensive, but when once installed, relieve the operator of a great deal of trouble, and saves the owner a great deal of time. An efficient radiator is absolutely essential in getting proper service from a tractor motor. This radiator must be backed up by a positive dirven fan and by a pump capable of properly circulating the water. By the use of this equipment and not without, can the modern kerosene motor be satisfactorily cooled. Only those who have had experience with inefficient tractor cooling systems can realize the importance of the functions which the cooling system on a tractor must perform.

Modine Spirex Radiator



E-B Gear Driven Centrifugal Water Circulating Pump



Right hand view of Motor showing Magneto, Water Pump and Inspection Plates in Oil Casing. Note also Clutch Spring in Fly Wheel

MOTOR SPEEDS

Chart XII.

It is the piston speed that determines the life of a motor—not the number of revolutions per minute.

The big single cylinder engines with a 10-inch bore and a 12-inch stroke, traveling at the rate of 175 revolutions per minute, which would seem to be a slow moving engine, has a piston speed of exactly 750 feet per minute. The smaller four cylinder motor with a 4¾-inch bore and a 5-inch stroke, whose crank shaft turns 900 revolutions per minute has a piston speed of extactly 750 feet per minute. If either of these crank shafts were free from the pistons, these same shafts might be run at a speed of several thousand revolutions per minute and the bearings could be lubricated and no harm would result from this speed, but it is this item of piston travel which must be very closely watched, as beyond a certain limit of piston travel the lubrication of the pistons and cylinders is a very difficult matter.

The day was when the high speed motors were ordinarily referred to as motors which had a comparatively high crank shaft speed, but we may all be thankful that that day has passed. The public now, in general, when speaking of a high speed motor, very quickly thinks of its piston travel, instead of its crank shaft speed.

COMPARISONS

COVERING 1, 2 AND 4 CYLINDER MOTORS IN THE SO CALLED SLOW SPEED CLASS AND E-B 4 CYLINDER MOTOR

Number of Cylinders	Stroke inches	Rev. per Minute	Piston Speed per Minute
1	10	500	2 x 10 x 500=10,000÷12=833⅓ ft.
2	12	400	2 x 12 x 400= 9,600÷12=800 ft.
4	8	650	2 x 8 x 650=10,400÷12=866⅔ ft.
E-B 4	5	900	2 x 5 x 900= 9,000÷12=750 ft.

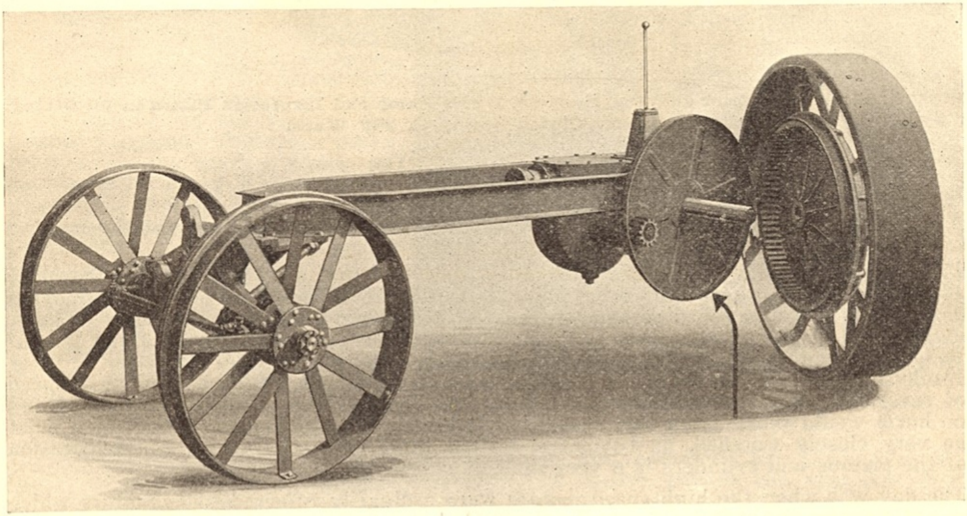
TRANSMISSION

Chart XIII.

In the transmission of power, friction must be overcome as far as possible.
Hyatt Roller Bearings overcome friction.
Perfectly machine cut, heat treated, hardened steel gears reduce friction.
Efficient lubrication (bath of oil) reduces friction.
Fill with steam cylinder oil to hole in rear.
Use semi-fluid grease for belt pulley gears.
Do not attempt to shift gears until the clutch is entirely released and all gears have stopped.
The importance of correct belt speeds.

A tractor transmission which will most efficiently transmit power from the motor to the draw bar and which will be practically free of wear is more expensive to manufacture than one of the old style of cast gear construction whose shafts are mounted on ordinary cast iron or babbit bearings.

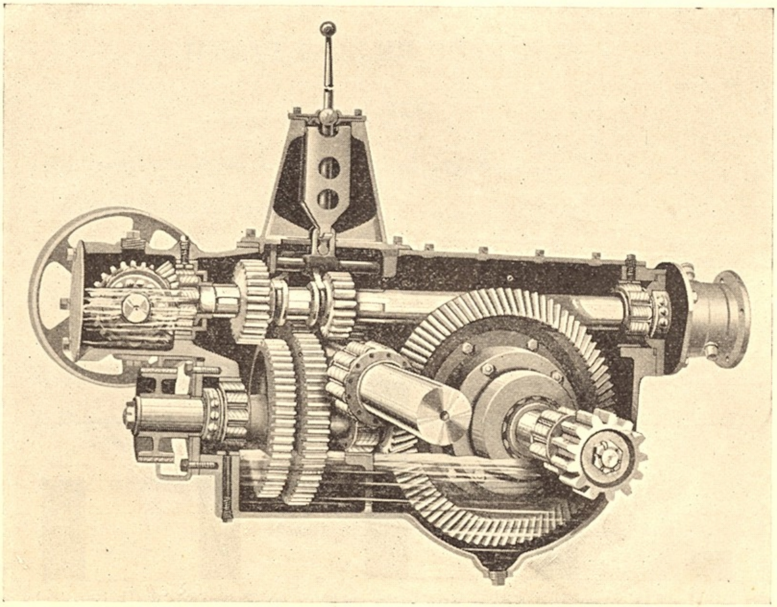
The tractor buyer of today, however, is not looking for the tractor which can be purchased for the least number of dollars, but is looking for the greatest value that can be obtained for the money expended.



View Showing Enclosed, Dust Proof Transmission on E-B Tractor

Perfectly cut, perfectly hardened steel gears transmit power with a great deal less friction than the older style of cast gears, and in doing so greatly lengthen their own life and deliver a materially greater percentage of the motor's power at the draw bar than do those of the older type of construction. Shafts turn a great deal easier on Hyatt Roller Bearings than on the old type of plain bearings, and on this account the modern tractor buyer insists that his tractor transmission be mounted on Hyatt Roller Bearings. A tractor transmission so built may be run in a bath of oil thus still further reducing friction, and practically eliminating wear.

The Hyatt Roller Bearing was originally designed for this type of heavy duty work. It was not designed to take care of any heavy end thrust which might exist on shafts and we believe that the proper way to take care of such thrust where it does exist, is to use a bearing especially dsigned for this work, namely a ball thrust bearing. The Hyatt Roller Bearing was designed to carry a radial load, and in this capacity it is without an equal.



Sectional view of E-B Transmission Case showing roller and ball bearings and oil level in main casing and thresher gear compartment

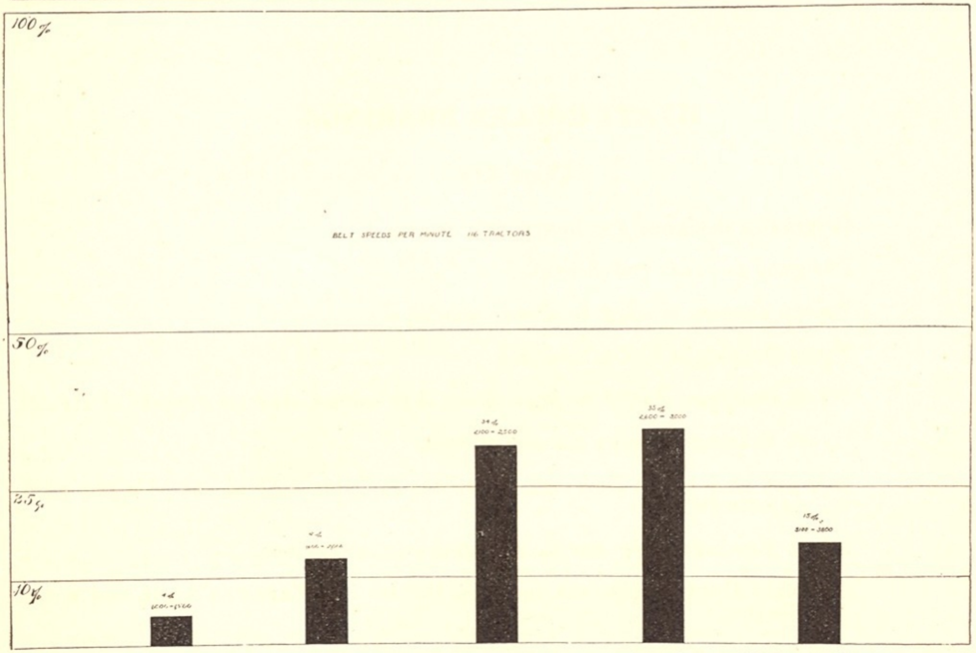
The rollers of the Hyatt Roller Bearing being hollow and flexible enable the bearing to absorb shocks which otherwise migh well be expected to injure the bearing. This spiral spring roller being made in right and left turns enables the Hyatt Roller Bearing to be absolutely self-lubricating as long as there is any oil left on any part of the bearing. This same feature also enables the Hyatt Roller to force any dirt or foreign matter which might by chance get on the bearing, to the inside of the roller where it can do no harm to the bearing.

Some of the very first Hyatt Roller Bearings which were put in E-B tractors in 1913 are still in use and are not in need of adjustment, showing that these bearings are frictionless and not subject to wear.

Gears which are mounted on shafts carried by Hyatt Roller Bearings are always in line on account of the absence of wear, and on this account the life of the gears is indefinitely prolonged.

Complete Hyatt equipment includes a set of hardened spiral spring rollers and two hardened sleeves, the inner one of which fits tightly over the shaft inside the rollers, the outer sleeve fitting in the transmission housing, thus having the hardened spring rollers riding in a hardened sleeve on either side.

Practically the only items of care in connection with a transmission built in this modern way are keeping sufficient oil in the transmission housing to properly lubricate the bearings and gears and the use of ordinary care in the shifting of gears to different speeds. If this care is exercised a transmission of this kind will last indefinitely.



Most every kind of a machine from ensilage cutter to fanning mill is made to run at a certain speed determined by that speed at which it does the best work. Therefore, before belting up to a piece of machinery figure the speed at which that machine will run with the motor running normally. The pulley on the machine may be too large or too small to get the required speed and thus necessitate a change to accommodate the speed of the tractor pulley.

To find the speed of the machine to be driven proceed as follows: Multiply the number of inches in the diameter of the pulley on the tractor by its number of revolutions per minute and divide the product by the number of inches in the diameter of the pulley on the machine to be driven. The quotient will be the number of revolutions the machine will be driven per minute.

Example: Suppose the tractor is to drive a shredder which is equipped with a pulley 9 inches in dameter.

$$\frac{12 \times 900}{9} = 1200$$

This shredder will be driven 1200 revolutions per minute.

To find what size pulley will give the required speed proceed as follows: Multiply the number of inches in the diameter of the pulley on the tractor by its number of revolutions per minute and divide the product by the number of revolutions per minute the pulley on the machine to be driven is required to run. The quotient will be the diameter in inches of the pulley that must be used to obtain that speed.

Example: Suppose the tractor is to drive the above shredder and that the speed of the shredder must be about 800 revolutions per minute.

$$\frac{12 \times 900}{800} = 13\tfrac{1}{2}''$$

To drive the above shredder at a speed of 900 revolutions per minute with this tractor the shredder must be equipped with a drive pulley 13½″ in diameter.

HYATT ROLLER BEARINGS

Chart XIV.

Originally designed for heavy duty work.

Designed to carry radial load.

Design enables bearing to absorb shocks.

Hyatt Bearing is self lubricating.

While Bearings should be kept clean, dirt cannot stay on outside of Hyatt.

Hyatt Bearings require no adjustment.

E-B put first Hyatt Bearings in tractor in 1911. Still in use—Do not need adjustment.

Hyatt Bearings keep shafts and gears in alignment.

Complete Hyatt equipment includes Rollers and hardened inner and outer sleeves.

WHAT S. A. E. MEANS TO THE TRACTOR OWNER

Chart XV.

What does it mean for the initials S. A. E. to appear on your tractor?

S. A. E. are the initials of the Society of Automotive Engineers, a body composed of the leading automobile and tractor engineers of the world.

S. A. E. specifications mean that the best engineers have recommended their use as the safest and most efficient.

S. A. E. rating means that in order for the tractor to deliver its rated horse power it is only necessary for it to develop and use 80% of its actual power, meaning that you have a 25% surplus of power for the tough spot ahead and that you are actually getting 25% more power than you bought.

The Society of Automotive Engineers has recommended a plowing speed of 2.33 miles per hour as the most practical speed possible for operation with implements as they are designed today.

E-B Tractors are the first to be standardized according to S. A. E. specifications, rating and speed, thus giving E-B customers the benefit of the brains of the greatest engineers of the world.

EMERSON-BRANTINGHAM LEADERS IN TRACTOR DESIGN FOR 12 YEARS

Chart XVI.

(1) The Emerson-Brantingham Implement Company is justly proud of the foundation upon which the E-B Tractor of today is built. In looking into the history of tractors a fact which stands out prominently is that the factory which at the present time produces the majority of he E-B Tractors, in 1906 built some of the very first tractors that were placed on the market and since that time has continuously built tractors in ever-increasing quantities. This fact may also well tend to give E-B customers, or prospective customers, a confidence in the tractors which that same factory is manufacturing today. As further evidence that your confidence is not misplaced we wish to point out the fact that during this period the Emerson-Brantingham Company have been leaders and not followers. To show how practical they were and with what ability they sized up the situation as to the demands which would be made of the tractor and as to the type of machine which would most nearly meet these demands. It is only necessary to cite a few instances of features which were established in E-B design during more recent years, being copied by other manufacturers of farm tractors.

(2) Emerson-Brantingham were the first to manufacture and adopt as standard the four cylinder, heavy duty tractor motor. Since that time the tendency toward the use of the heavy duty four cylinder tractor motor has increased steadily until at the present time practically all of the manufacturers of farm tractors are putting out four cylinder tractors.

(3) Emerson-Brantingham were the first to burn kerosene in a four cylinder motor. Today the demand is very limited for any except kerosene tractors and all manufacturers are endeavoring to fall in line with equipment calculated to handle kerosene.

(4) Emerson-Brantingham were the first to use a multi-speed enclosed transmission running in oil. This principle goes a long way toward making the tractor durable and has since been copied to some extent, but generally speaking, a great deal still remains in regard to the proper housing of working parts.

(5) Emerson-Brantingham were the first to use machine cut case hardened gears. Machine cut case hardened gears are becoming more and more prevalent and go a long way toward making a tractor efficient and durable.

(6) Emerson-Brantingham were the first to use the producer type Carburetor—the carburetor which is at the present time without an equal as to its ability to deliver to the motor at all times a properly mixed charge of fuel and air regardless of the grade of kerosene, distillate or gasoline used.

(7) Emerson-Brantingham were the first to use Hyatt Heavy Duty Roller Bearings and the very first of these bearings are still in use and are not in need of adjusting. Needless to say a great many other manufacturers of tractors have fallen in line and are using the Hyatt Heavy Duty Roller Bearings.

(8) Emerson-Brantingham were the first to use the K. W. High Tension Magneto with Impulse Starter. This magneto is at the present time the standard by which tractor magnetos and ignition systems are judged.

(9) Emerson-Brantingham were the first to use a gear driven fan. Only those who have had field experience with other methods of fan drives are competent to judge the relief given by the gear driven fan.

(10) Emerson-Brantingham were the first to standardize according to S. A. E. specifications and adopt the S. A. E. rating.

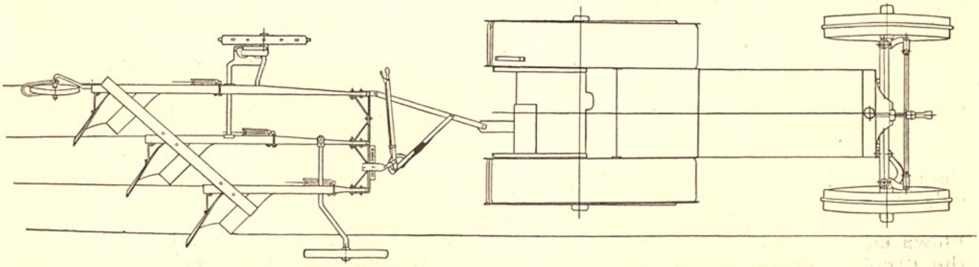
(1) All four wheels should be on unplowed ground to obtain good footing and avoid packing subsoil.

The tractor that travels on the unplowed ground when plowing is the ideal machine. It is always level, it steers easier, it is narrower and therefore not clumsy, it does not break down the land side of the furrow, and most important of all, it is traveling on good footing which prevents slippage of the drivers and it does not pack the subsoil like a tractor traveling in the bottom of the furrows.

(2) The Plowing Speed should not be greater than the speed at which implements will do the best work. There are many objections to both the extremely slow speed and extremely high speed tractors. In the last few years manufacturers have been rapidly increasing the speed of their tractors, in fact, many have figured that if 2½ miles per hour was a good plowing speed, 3½ ought to be better, entirely overlooking the fact that implements as manufactured today will not do good work at such high speed.

The Society of Automotive Engineers have given this point considerable study and have decided that 2.33 miles per hour is the speed best suited to present day implements.

(3) Tractor must turn short enough to reduce the headlands to minimum. The tractor with a reasonably short turn is not only a great convenience in handling, but makes a more practical plowing machine. The headlands can be reduced and plowed out much easier and the unplowed land left in the corners is negligible.



Top view of E-B 12-20 Model AA Tractor Properly Hitched to E-B Plow

PLOWING

Chart XVII.

(1 and 2) One of the strongest objections that has ever been raised to the use of tractors on the farm is the packing of the soil, and this prejudice has been largely caused from the fact that the first tractors were very heavy weight and consequently the effect of the soil packing was readily noticed in the crop yield. There isn't any question, particularly when the soil is wet, that unusual pressure squeezes the life out of it, and it will be several years before the action of the air and moisture will disintegrate the molecules which have been so firmly cemented by this pressure to such extent that the soil is back in its original plant food form.

With most of the light tractors made today, in order to simplify the construction of the tractor, the drive wheels are 6 to 8 feet from outside to outside. With such a tractor, with power for not more than three or four 14-inch bottoms, is is necessary to run one drive wheel in the furrow. Regardless of any system of lugs that can be put on the drive wheel, it cannot be successfully denied that the drive wheel running in the bottom of the furrow where the ground is moist does interfere with the plant food properties of that part of the soil which comes in contact with the face of the drive wheel, but the effect on the soil is far less serious than the effect on the tractor. Very few tractors are made to run with one side lower than the other. With one drive wheel in the furrow the tractor is really working on a side hill all the time, and working on a side hill we know that the greater portion of the load is carried on the lower wheel, consequently that side of the tractor will wear out first. Furthermore, all who have observed tractors running with one drive wheel in the furrow have noticed much greater slippage from the wheel in the furrow than from the wheel on the land, with the result that there is a constant grinding out of the differential, so that from the point of the life of the tractor it is entirely reasonable to figure that with one wheel running in the furrow the life of the tractor is reduced one-fourth.

To compare with the above picture take a tractor designed with a maximum width from outside to outside of drive wheels of sixty inches. The center of the power in this tractor, therefore, is thirty inches load can be made to pull straight ahead when hitched to at one corner is to have it on a track or guided by wheels or other means that will take off this side pull.

Some tractors are made with the spur gear construction, which throws more strain on the crankshaft, and necessitates the setting of the motor crossways of the frame of the tractor, which requires a very wide construction. These wide tractors must run one drive wheel in the furrow, which is equal to running the tractor during its entire plowing life on a side hill. This forces a continued grind on the differential by reason of the extra slippage of the drive wheel in the furrow over the drive wheel on the land. It must decrease the available plant food in that part of the soil which comes in contact with the drive wheel in the furrow. The splash system of lubrication, which is recognized as the most economical and least liable to cause serious trouble does not function so well when one side of the tractor is running continually lower than the other, as when the tractor runs comparatively level.

It would seem as though, from the facts outlined above, the best interests of the farmer customer would be served by purchasing a 4 wheel tractor that is not so wide but that all wheels may run on the land without excessive side draft.

(3) We hear a great deal about plowing speeds, and this point has troubled many tractor manufacturers. Plows as they are manufactured today are designed to operate at horse speeds, or about 2 miles per hour. It has been found that this speed can be increased somewhat without effecting the good work of the plow. The Society of Automotive Engineers in studying this point have recommended a speed of 2.33 miles per hour as best adapted to implements as manufactured today.

(4) A reasonably short turn is necessary on a tractor, not only to enable the operator to conveniently handle the machine but to make it possible to plow out the headlands and corners without the aid of horses.

In laying out a field set a stake in the center of each end of field but 10 or 15 steps closer to the ends than to the sides to allow for narrowing of the plow in turning the ends. Start at the left of the stake at point marked "Starting Point." When reaching the other stake swing to he right and plow until you reach the center line of the stakes, then lift plows and turn around (indicated by dotted lines) swinging in again on a curve so as to round up the ends. As soon as enough width is obtained (75 to 100 feet) to turn the engine around the ends, the plows may be left in the ground and continue plowing all the way around. CAUTION: If the ground is exceptionally hard, raise front end of first section allowing rear plows to make the turn.

POWER REQUIRED TO PULL THREE BOTTOM PLOW
UNDER DIFFERENT CONDITIONS

Type of Soil	Lay of Land	Depth of Plowing	Draft per Plow	Speed M.P.H.	H.P. Required
Sandy Loam	Level	4.88	285	2.3	5.25
Sandy Loam	Level	6.80	460	2.3	8.48
Wet Gumbo	Level	6.80	650	2.3	11.98
Hard Pan or Gumbo	10% Grade	6.80	650	2.3	15.62

DRAW BAR HORSE-POWER

Many tractor owners do not realize the real meaning of the term "Draw Bar Horse-Power." The rating given a tractor by the manufacturer states the horse-power the tractor will develop at the drawbar, when properly operated under average conditions. That horse-power will be developed on high or on low gear, although the load pulled or , we will say, the actual number of pounds draw bar pull, will not be the same.

A twelve horse-power tractor geared to travel at the rate of one and one-half miles per hour will, on ordinary footing, develop twelve horse-power at the draw bar, which means a pull of a certain number of pounds. But change that speed to two and one-half miles per hour and the number of pounds draw bar pull will be greatly decreased, although the tractor still develops its twelve horse-power.

Any five thousand-pound tractor, traveling at 2.3 miles per hour up a 10% grade requires 3.1 horse-power more than it takes on the level. In other words, the draw bar pull is reduced 3.1 horse-power. A 5 per cent grade would require just one-half the above, or 1.55 horse-power.

In the case of a tractor pulling loaded wagons, a different draw bar pull per ton will be required, depending on the condition of the road and whether the load is pulled on the level or up hill.

In the case of a tractor pulling plows, a different draw bar pull per plow will be required, depending on the condition of the soil.

In order that you may form some idea as to the difference all these conditions will make, we show below a table taken from some of the leading Farm Journals, showing the draw bar pull required for a load of one ton in a wagon and for one plow bottom in various soils.

USEFUL INFORMATION

DRAW BAR PULL REQUIRED FOR A LOAD OF ONE TON IN WAGON

	Good Road Lbs.	Gravel Lbs.	Sand Lbs.
On the level	125	250	625
Rise of 1 foot in 100 feet	145	290	725
Rise of 2 feet in 100 feet	165	330	825
Rise of 3 feet in 100 feet	185	370	925
Rise of 4 feet in 100 feet	205	410	1025
Rise of 5 feet in 100 feet	225	450	1125
Rise of 6 feet in 100 feet	245	490	1225

DRAW BAR PULL REQUIRED FOR ONE PLOW IN VARIOUS SOILS

A tractor traveling at 2.33 miles per hour will travel 204 feet in one minute. For plowing, the following table shows the time and distance required to plow one acre:

	12-inch Bottom			14-inch Bottom		
Depth	4 in.	6 in.	8 in.	4 in.	6 in.	8 in.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Sandy	144	216	288	168	252	336
Clover Sod	336	504	672	442	588	734
Clay	384	576	768	448	672	896
Virgin Sod	720	1080	1440	840	1260	1680
Gumbo	960	1440	1920	1120	1680	2240

Depth	4 in.	6 in.	8 in.
	Lbs.	Lbs.	Lbs.
Sandy	192	288	384
Clover Sod	448	672	896
Clay	512	768	1024
Virgin Sod	960	1440	1920
Gumbo	1280	1920	2560

1—12-in. Plow traveling 43,560 ft.=1 acre
2—12-in. Plows traveling 21,780 ft.=1 acre
3—12-in. Plows traveling 14,520 ft.=1 acre
4—12-in. Plows traveling 10,890 ft.=1 acre
1—14-in. Plow traveling 37,400 ft.=1 acre
2—14-in. Plows traveling 18,700 ft.=1 acre
3—14-in. Plows traveling 12,466 ft.=1 acre
4—14-in. Plows traveling 9,350 ft.=1 acre
1—16-in. Plow traveling 32,700 ft.=1 acre
2—16-in. Plows traveling 16,350 ft.=1 acre
3—16-in. Plows traveling 10,900 ft.=1 acre
4—16-in Plows traveling 8,175 ft.=1 acre

(The above also applies to tractor traveling 1.81 miles per hour.)

TRACTOR TRAVELING AT 2.33 MILES PER HOUR

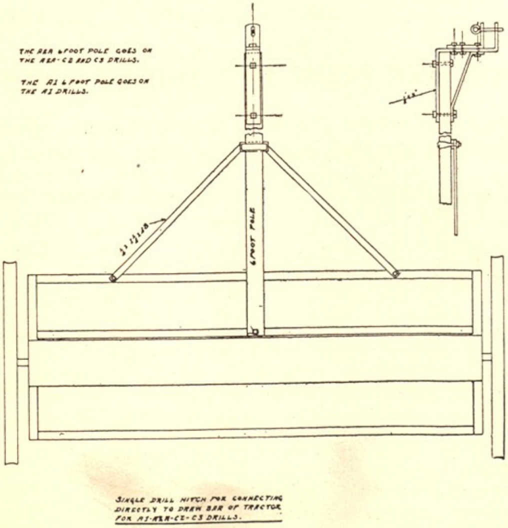
1—12-in. Plow traveling 214 min.=1 acre
2—12-in. Plows traveling 107 min.=1 acre
3—12-in. Plows traveling 71⅓ min.=1 acre
4—12-in. Plows traveling 53½ min.=1 acre
1—14-in. Plow traveling 183 min.=1 acre
2—14-in. Plows traveling 91⅓ min.=1 acre
3—14-in. Plows traveling 61 min.=1 acre
4—14-in. Plows traveling 45¾ min.=1 acre
1—16-in. Plow traveling 160 min.=1 acre
2—16-in. Plows traveling 80 min.=1 acre
3—16-in. Plows traveling 53⅓ min.=1 acre
4—16-in. Plows traveling 40 min.=1 acre

TRACTOR TRAVELING 1.81 MILES PER HOUR

1—12-in. Plow traveling 273⅓ min.=1 acre
2—12-in. Plows traveling 137⅔ min.=1 acre
3—12-in. Plows traveling 91⅓ min.=1 acre
4—12-in. Plows traveling 68½ min.=1 acre
1—14-in. Plow traveling 234 min.=1 acre
2—14-in. Plows traveling 117⅓ min.=1 acre
3—14-in. Plows traveling 78¼ min.=1 acre
4—14-in. Plows traveling 58⅔ min.=1 acre
1—16-in. Plow traveling 224 min.=1 acre
2—16-in. Plows traveling 112 min.=1 acre
3—16-in. Plows traveling 74⅔ min.=1 acre
4—16-in. Plows traveling 56 min.=1 acre

The E-B 12-20 Tractor S. A. E. Rating will develop 12 horse-power at the draw bar when in good condition and properly operated on level ground sufficiently to give the tractor wheels a good footing. Twelve horse-power at 1.81 miles per hour means a draw bar pull of 2,490 pounds. Twelve horse-power at 2.33 miles per hour means a draw bar pull of 1,930 pounds.

TRACTOR HITCHES

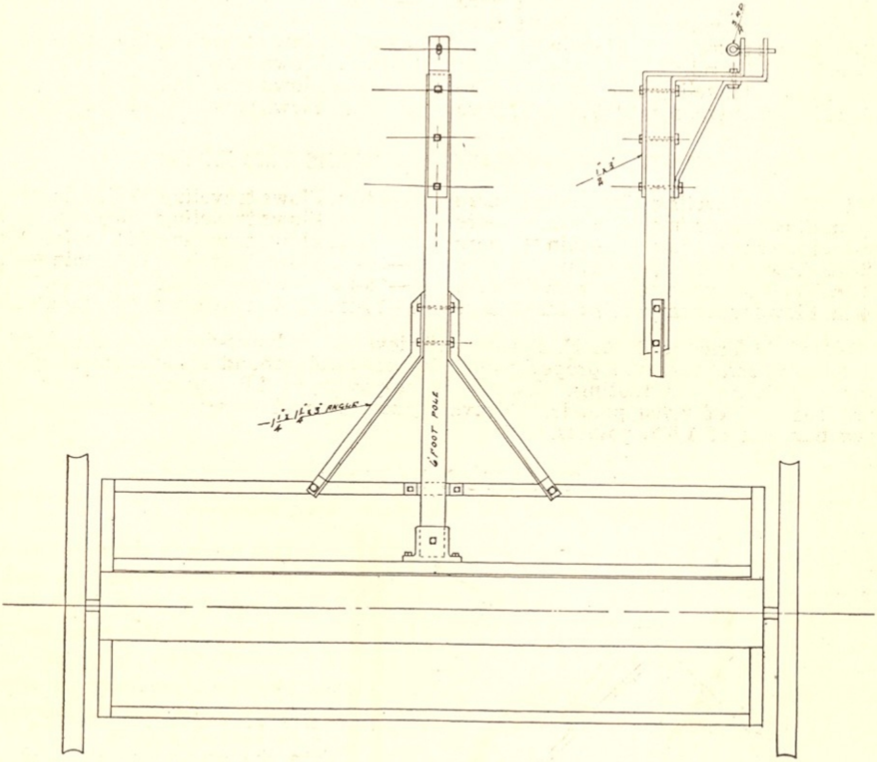

THE A2A 6 FOOT POLE GOES ON THE A2A-C2 AND C3 DRILLS.
THE A1 6 FOOT POLE GOES ON THE A1 DRILLS.
6 FOOT POLE
SINGLE DRILL HITCH FOR CONNECTING DIRECTLY TO DRAW BAR OF TRACTOR FOR A1-A2A-C2-C3 DRILLS.

TO attach one drill regardless of width to tractor

Note the adjustments up or down to conform to the different heights of tractor draw bars. The hitch is well braced, strong and substantial.

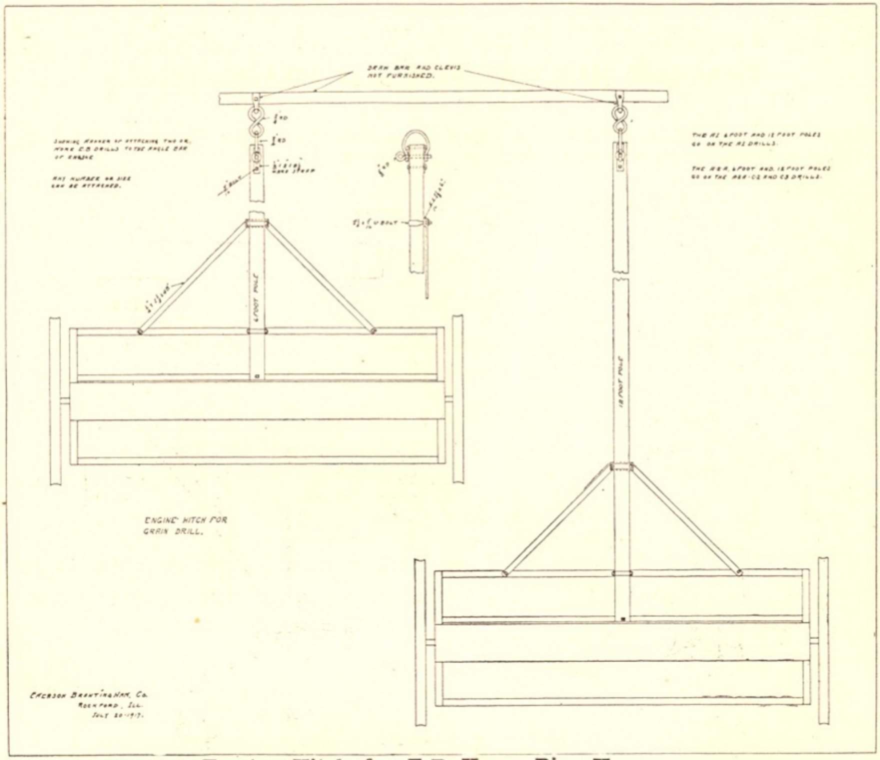
TRACTOR HITCHES FOR E-B GRAIN DRILLS

The hitch shown here is designed to work on a small tractor. Tests in the field have proven this hitch to be practical, strong and adjustable.

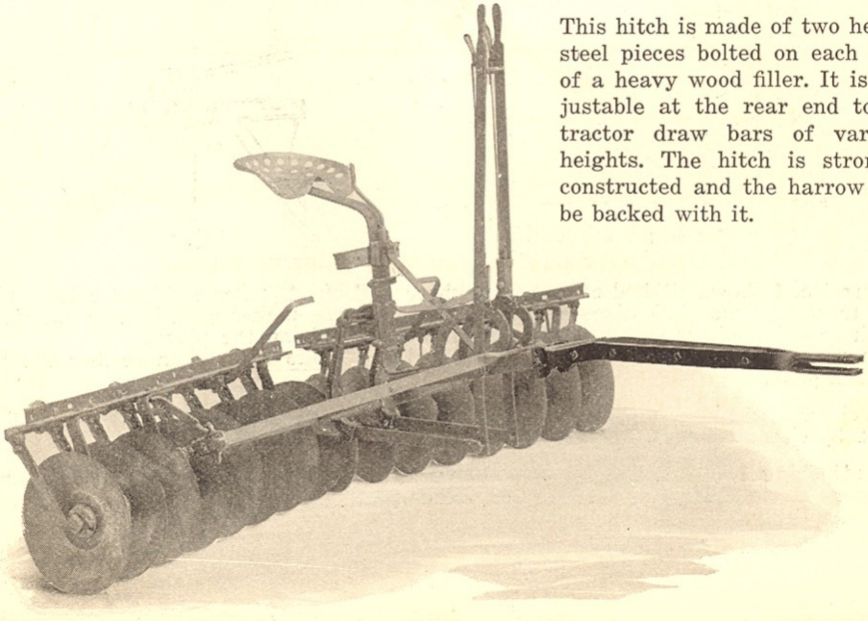


For Attaching Two or More Drills to Tractor

This hitch allows for turning to right or left with no danger of injury to either drill. It is quickly attached and will work behind almost any make of tractor. To attach three drills a longer draw bar is required, the long tongue drills working on either side of short tongue drill.


DRAW BAR AND CLEVIS NOT FURNISHED.
SHOWING MANNER OF ATTACHING TWO OR MORE E.B DRILLS TO THE ANGLE BAR OF ENGINE
ANY NUMBER OR SIZE CAN BE ATTACHED.
THE A1 6 FOOT AND 12 FOOT POLES GO ON THE A1 DRILLS.
THE A&B, 6 FOOT AND 12 FOOT POLES GO ON THE A&B-C2 AND C3 DRILLS.
6 FOOT POLE
12 FOOT POLE
ENGINE HITCH FOR GRAIN DRILL.
EMERSON BRANTINGHAM CO.
ROCKFORD, ILL.
JULY 20-1917.

Tractor Hitch for E-B Horse Disc Harrower



This hitch is made of two heavy steel pieces bolted on each side of a heavy wood filler. It is adjustable at the rear end to fit tractor draw bars of various heights. The hitch is strongly constructed and the harrow can be backed with it.

TRACTOR HITCH FOR ATTACHING 2 OR 3 E-B POWER LIFT TRACTOR PLOWS TO TRACTORS

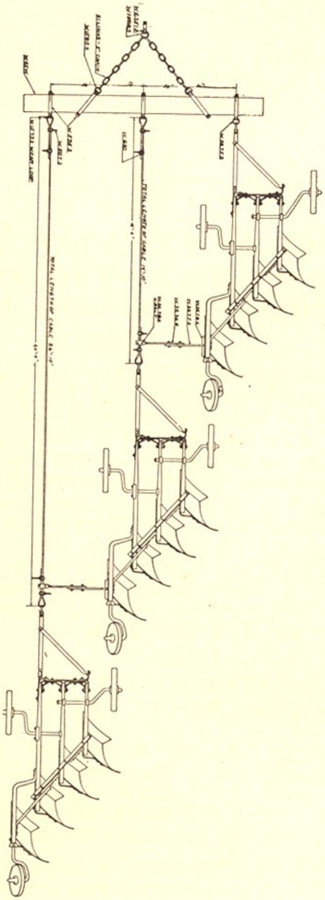


Fig. 1

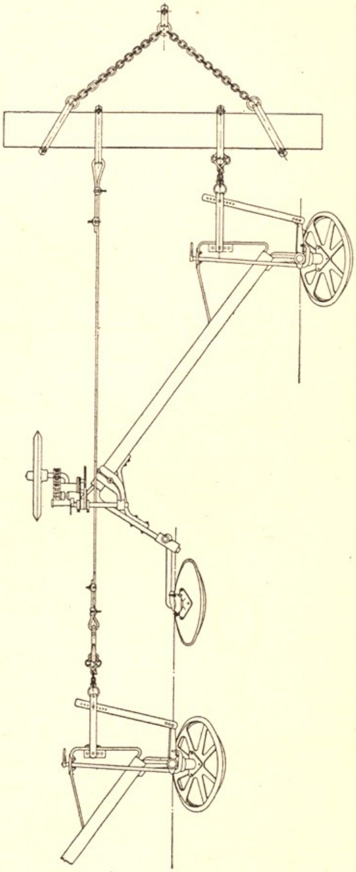


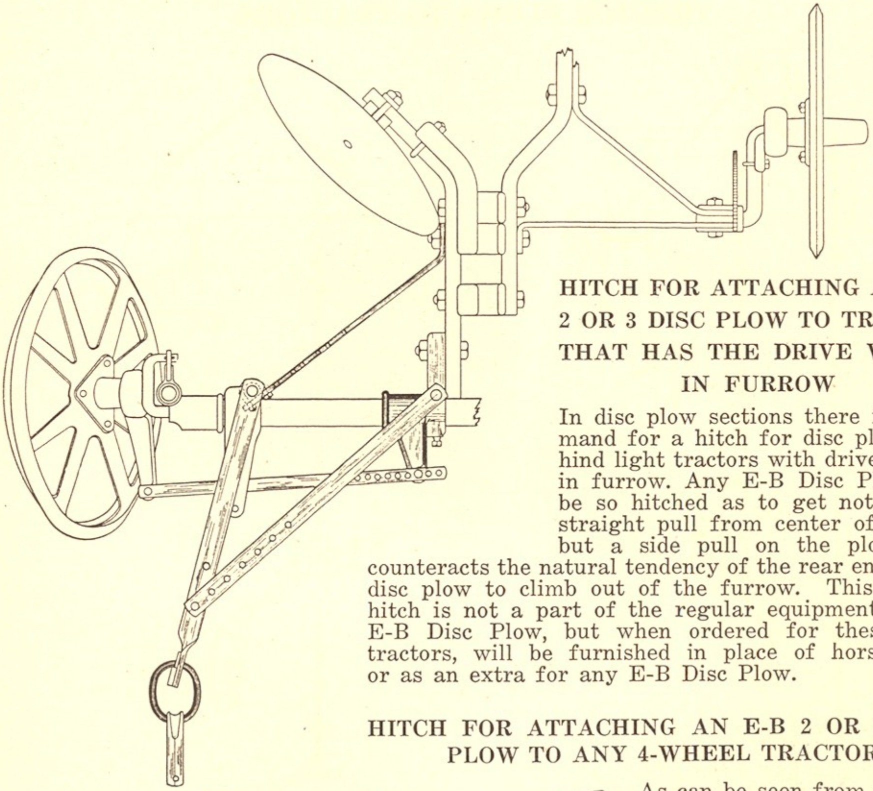
Fig. 2

Figure No. 1 shows method of attaching three E-B No. 103 Power Lift 4-bottom plows to a tractor. This hitch gives a straight line of draft, makes each bottom cut its full width and also allows turning oval corners without raising the plows.
Each plow is complete in itself; no change being made other than setting the hitch on each plow.

Two plows of three or four bottoms each can be attached to a tractor as shown in figure No. 2 by changing draw bar and chain hitch.

For attaching two E-B Tractor Disc Plows to a tractor, the hitch is used as shown in figure 2. No change is necessary in either plow and the hitch can be taken off or put on quickly.

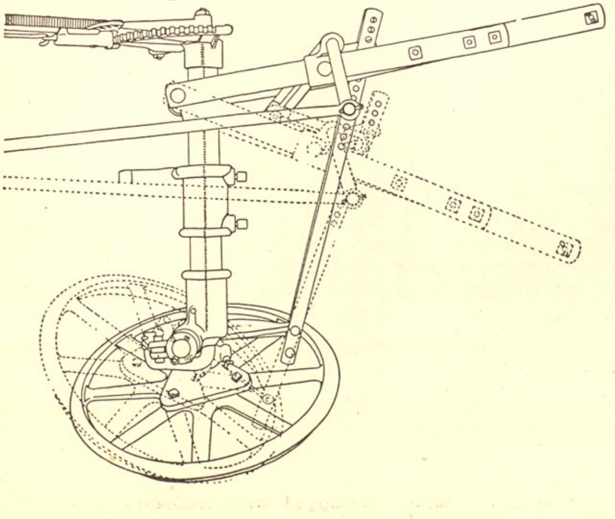
WRITE FOR CATALOG DESCRIBING E-B TRACTOR PLOWS



HITCH FOR ATTACHING AN E-B 2 OR 3 DISC PLOW TO TRACTOR THAT HAS THE DRIVE WHEEL IN FURROW

In disc plow sections there is a demand for a hitch for disc plows behind light tractors with drive wheels in furrow. Any E-B Disc Plow can be so hitched as to get not only a straight pull from center of power, but a side pull on the plow that counteracts the natural tendency of the rear end of the disc plow to climb out of the furrow. This special hitch is not a part of the regular equipment of the E-B Disc Plow, but when ordered for these light tractors, will be furnished in place of horse hitch or as an extra for any E-B Disc Plow.

HITCH FOR ATTACHING AN E-B 2 OR 3 DISC PLOW TO ANY 4-WHEEL TRACTOR



As can be seen from the picture, the hitch controls the front furrow wheel so that a full width cut will be made in the first furrow.

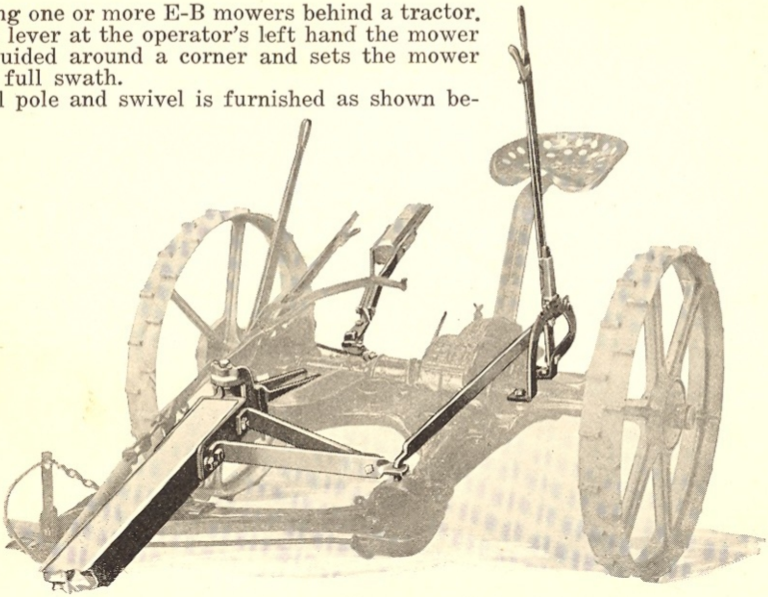
This hitch is adjustable and controls the rear furrow wheel also, so in turning corners the wheels revolve instead of skidding, as do many plows not equipped with this exclusive feature.

The Discs can be given such a set or angle as may be needed to meet the requirements of the condition the land may be in at any given time. The land conditions are not the same all the year. With the Disc Plow the land can be plowed when you are ready.

TRACTOR HITCH FOR E-B MOWERS

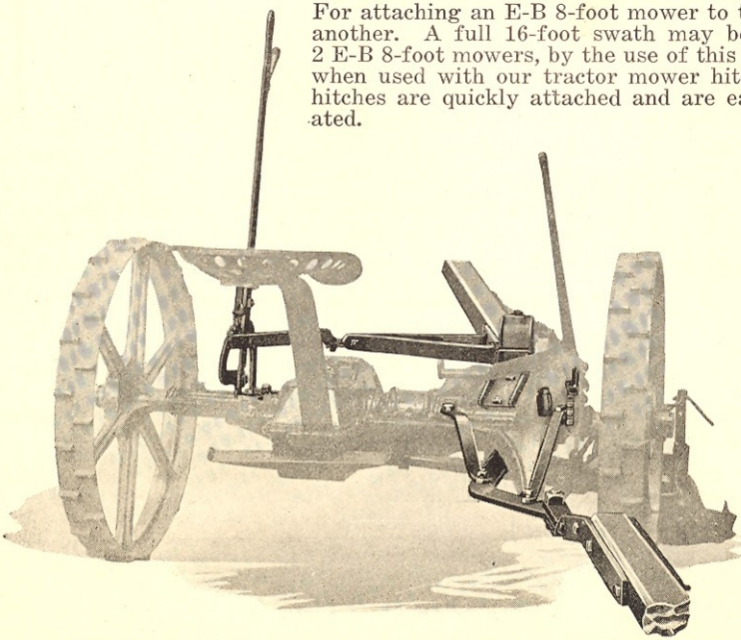
For pulling one or more E-B mowers behind a tractor. With the lever at the operator's left hand the mower can be guided around a corner and sets the mower to cut a full swath.

A special pole and swivel is furnished as shown below.



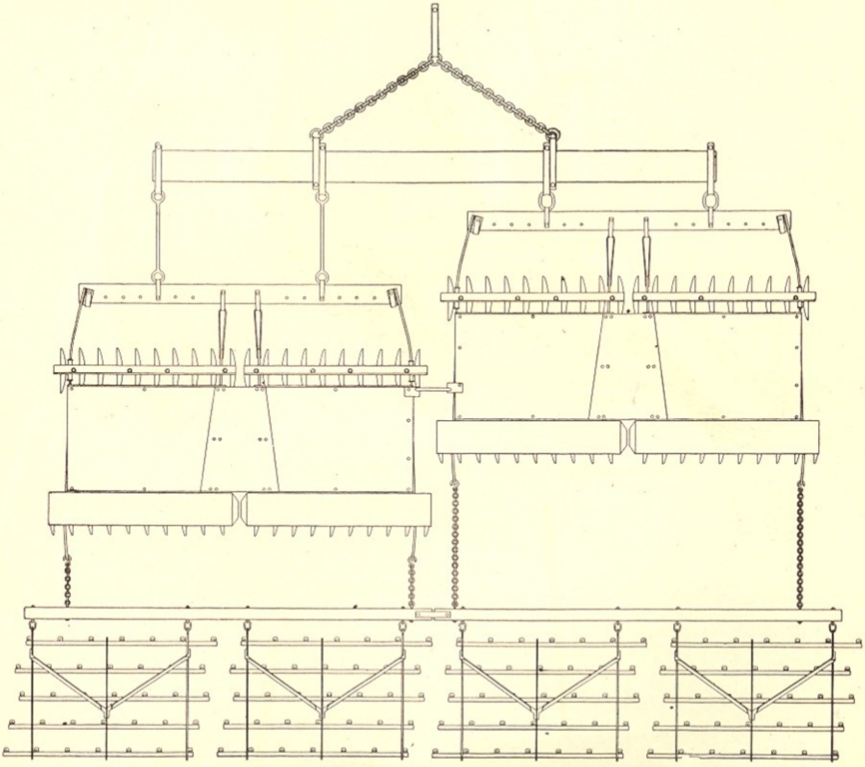
E-B Standard 8-Foot Mower with Tractor Hitch

For attaching an E-B 8-foot mower to the rear of another. A full 16-foot swath may be cut with 2 E-B 8-foot mowers, by the use of this connection when used with our tractor mower hitch. These hitches are quickly attached and are easily operated.



Rear View of E-B 8-Foot Standard Mower Equipped with Brackets to Attach Another Mower

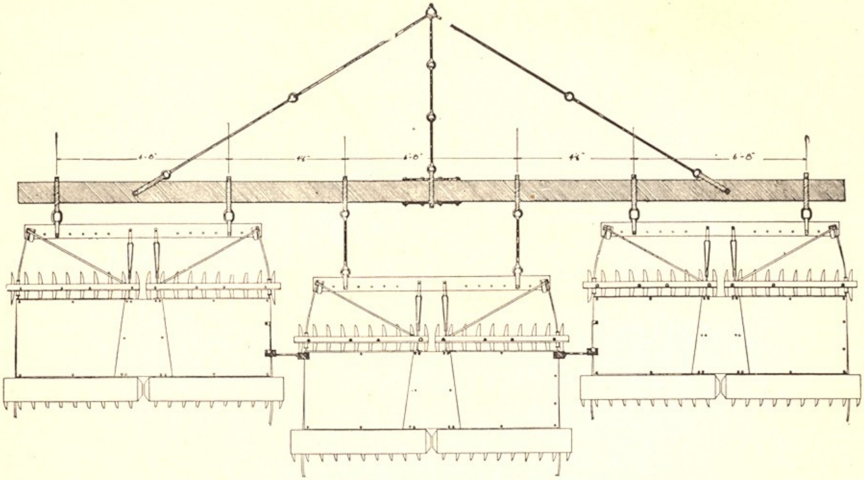
HARROW HITCHES



Two Abreast Engine Disc Harrow Hitch

The two and three abreast hitches were designed so two or three disc harrows could be pulled by a tractor and not run into each other in turning.

These have proven very satisfactory when used with the E-B Engine Disc Harrow which are made in 8 and 10 foot widths.

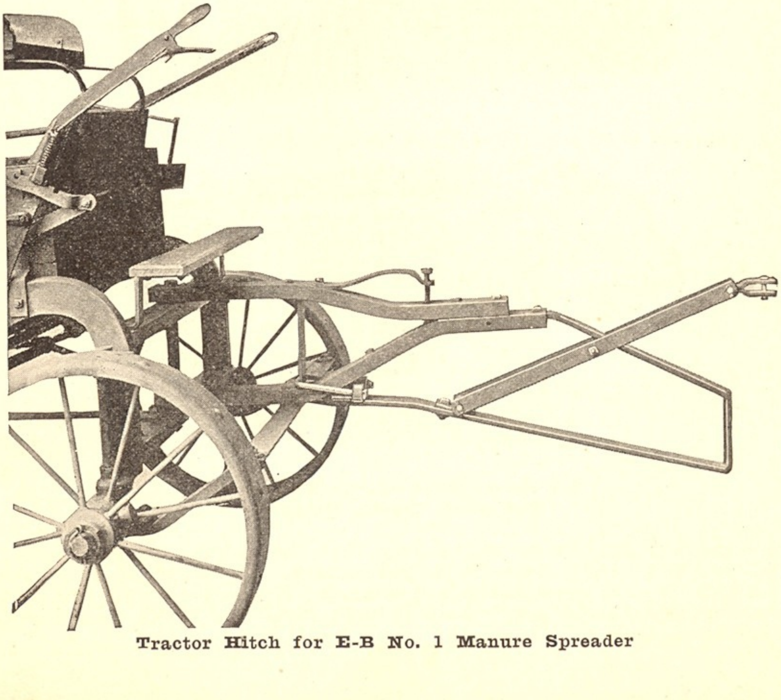


Three Abreast Engine Disc Harrow Hitch

TRACTOR HITCH FOR E-B No. 1 SPREADER

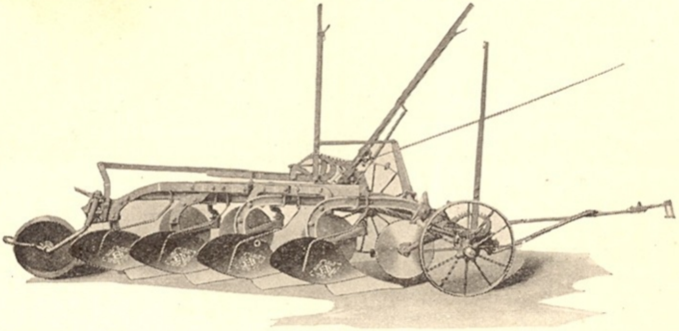
The Clevice draw bar adjusts itself to any height of hitch on a tractor. It is all steel, can be attached quickly, and does not disturb any part of the spreader as shipped for horse hitch.

Another machine that can be used with a tractor and money made while using it.

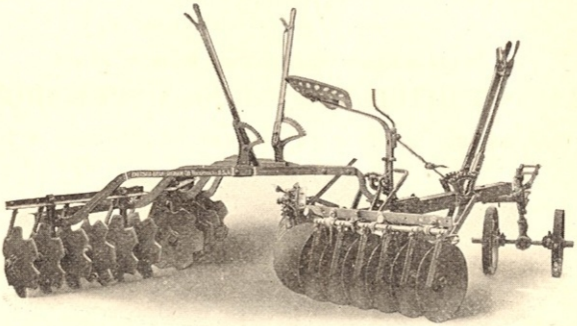


Tractor Hitch for E-B No. 1 Manure Spreader

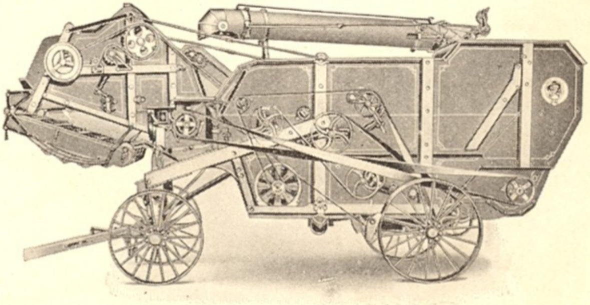
E-B TRACTOR TOOLS



E-B Engine Plows made in a variety of sizes and types to suit every condition and to fit any tractor.



Tandem Attachment shown in this cut can be furnished for E-B Harrows.



E-B Geiser No. 4 and No. 5 Thresher
The Small Tractor Thresher

Cleans by wind and gravity in such a way that the cleaning is practically perfect. Few parts, no unnecessary material to add weight. Workmanlike construction and efficient design. It is a grain saver and cleaner. It has been built for sixty years and in larger numbers every year. Built in sizes 24x32 and 27x39. Adapted to either steam or kerosene power.

The E-B Line

The Most Complete Line of Farm Machinery Manufactured

E-B Walking Plows
E-B Frameless Sulky Plows
E-B Foot Lift Sulky Plows
E-B Foot Lift Gang Plows
E-B Express Gang Plows
E-B Horse Disc Plows
E-B Tractor Moldboad Plows
E-B Tractor Disc Plows
E-B Middle Breakers
E-B Single Row Listers
E-B Double Row Listers
E-B Ridge Busters
E-B Tooth Harrows
E-B Harrow Carts
E-B Disc Harrows
E-B Tongue Trucks
E-B Transport Trucks
E-B Tandem Attachments
E-B Tractor Disc Harrows
E-B Corn Planters
E-B Cotton Planters
E-B One row Planters
E-B Potato Planters
E-B Stalk Cutters
E-B Walking Cultivators
E-B Disc Cultivators
E-B Riding Cultivators
E-B Two Row Cultivators
E-B Motor Cultivators
E-B Beet Cultivators
E-B Manure Spreaders
E-B Potato Diggers
E-B Rake Bar Loaders
E-B Cylinder Loaders
E-B Sulky Rakes
E-B Osborne Rakes
E-B Side Delivery Rakes
E-B Sweep Rakes
E-B Overshot Stackers
E-B Swinging Stackers
E-B Baling Presses
E-B Standard Mowers
E-B Osborne Mowers
E-B Gasoline Engines
E-B Kerosene Engines
E-B Binder Engines
E-B Pump Jacks
E-B Grain Drills
E-B Osborne Grain Binders
E-B Osborne Corn Binders
E-B Osborne Reapers
E-B Osborne Knife Grinders
E-B Osborne Twine
E-B Kerosene Tractors
E-B Gasoline Tractors
E-B Steam Tractors
E-B Steam Portable Engines
E-B Threshers
E-B Water Tanks
E-B Saw Mills
E-B Farm Wagons
E-B Trucks
E-B Buggies
E-B Auto Trailers